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The Species of Sebacina (Tremellales) of Temperate North America

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The genus *Sebacina* was established by Tulasne (Jour. Linn. Soc. Bot. **13**: 31–42. 1871) on two species which had been placed in the genus *Thelephora* by Persoon (Syn. Fung. 577. 1801) and there retained by Fries (Syst. Myc. **1**: 448. 1821). *Sebacina* (*Thelephora*) *incrustans* is coriaceous in texture, while *S.* (*Thelephora*) *caesia* is gelatinous. Both are incrusting forms, growing over the ground and associated litter in moist woods. With the increasing emphasis on microscopic characters as taxonomic criteria, more and more resupinate fungi have been referred to *Sebacina* because of their possession of longitudinally septate basidia.

In 1908 Bresadola (Ann. Myc. **6**: 46. 1908) proposed a subgenus *Bourdotia*, based on *Sebacina Galzinii*, for those species of *Sebacina* possessing gloeocystidia. Bresadola and Torrend later raised *Bourdotia* to the rank of a genus (Broteria ser. bot. **11**: 88. 1913).

Bourdot (Trans. British Myc. Soc. **7**: 53. 1921) proposed a subgenus *Heterochaetella* for forms of *Sebacina* possessing cystidia, with *S. dubia* as the type. He also referred *Sebacina crystallina*, described as a new species in the same paper, to the new subgenus. Bourdot and Galzin (Hym. Fr. 52. 1928) later recognized *Heterochaetella* as a separate genus.

In 1888 Brefeld (Untersuch. **7**: 94. 1888) proposed a subgenus *Exidiopsis* in the genus *Exidia*, based upon *Exidia effusa*. The subgenus was characterized as possessing an effused, *Corticum*-like habit, waxy-gelatinous consistency, allantoid spores and spore germination by production of curved conidia typical of *Exidia*. Möller (Protobasid. 167. 1895) elevated *Exidiopsis* to the rank of a separate genus, at the same time describing several new species for the group. He proposed also the erection of a subfamily Exidiopsideae to include the genera *Exidiopsis*, *Heterochaete* and *Sebacina*, in order further to emphasize the segregation of resupinate forms from pileate members of the Tremellaceae.

Patouillard (Essai Tax. 25. 1900) in his taxonomic survey of the hymeno-

mycetes included a section *Hirneolina* in the genus *Sebacina* for forms which are resupinate except for free and either appressed or slightly involute margins. Bresadola (Ann. Myc. **1**: 115. 1903) erected the genus *Eichleriella*, which clearly included the forms represented by the section *Hirneolina*, and then in 1905 (cited by Saccardo, Syll. Fung. **17**: 208. 1905) recognized *Hirneolina* as the generic name, with the consequent reduction of *Eichleriella* to synonymy. Patouillard (Bull. Soc. Myc. Fr. **40**: 31. 1924) later recognized the validity of the genus *Hirneolina*, first used by himself as a section of *Sebacina*. Both approved, then, the erection of a genus for nearly resupinate Tremellaceae with only the margins free. Assuming for the present that such a genus is a natural one, the question arises as to what name should be applied. *Hirneolina* obviously has priority as a name for the group, and has the added advantage that both of the men who figured directly in the erection and naming of the group finally recognized it as the generic name. On the other hand, the group was first given generic rank under the name *Eichleriella*, and this name has been used almost exclusively by succeeding workers in dealing with organisms of this group. On the basis of common usage it seems to be the more desirable choice in a situation not too clearly covered by the rules of nomenclature.

Möller (Protobasid. 166. 1895) published a new genus *Stypella*, founded upon *S. papillata* and *S. minor*, resupinate gelatinous forms arising as minute pustules scattered on an arachnoid subiculum. No other clearly analogous forms have since been discovered, with the possible exception of *Tremella Grilletti* and *Sebacina crystallina*, the identities of which have not been very clearly established. The group seems to differ from *Sebacina* in that pustules are formed along or at the corners of a superficial arachnoid web of hyphae, while the scattered patches or pustules of species of *Sebacina* are not connected by any such network.

The general treatments of the resupinate Tremellaceae have been extremely varied. Möller (Protobasid. 75–94, 166–168. 1895) recognized the separate genera *Sebacina*, *Heterochaete*, *Exidiopsis* and *Stypella*, the first three comprising the subfamily Exidiopsideae, and the last named composing a subfamily Stypelleae. Patouillard (Essai Tax. 24–25. 1900) divided them into but two genera, *Heterochaete* and *Sebacina*, the latter made up of four sections, *Sebacina*, *Stypella*, *Exidiopsis*, and *Hirneolina*, the last not truly resupinate. Rea (British Basid. 737–738. 1922) recognized the three subgenera *Eusebacina*, *Heterochaetella* and *Bourdotia*. Gäumann (Vergleich. Morph. Pilze. 478–480. 1926) recognized *Stypella* and *Exidiopsis* as distinct genera and included *Bourdotia* in *Sebacina*. Gäumann and Dodge (Comp. Morph. Fung. 520–521. 1928) divide *Sebacina* into four subgenera, including true *Sebacina*, *Exidiopsis*, *Stypella* and *Bourdotia*. Killermann (in E. & P., Nat. Pfl. 2 ed. **6**: 113–115. 1928) treats *Hetero-*

chaetella as a subgenus of *Heterochaete*, and divides *Sebacina* into the subgenera *Bourdotia*, *Tremellodendron*, and an unnamed group which includes species commonly placed in *Sebacina*, species sometimes referred to *Exidiopsis*, one species placed by its author in *Heterochaete* and another which obviously belongs in the *Bourdotia* group. He treats *Exidiopsis* as a separate genus, including in it two species described by Möller and two which were described and referred by Bresadola to *Sebacina*, one of them with gloeocystidia. Bourdot and Galzin (Hym. Fr. 35–53. 1928), in the most complete treatment of the genus to date, recognize the three resupinate genera, *Bourdotia*, *Heterochaete* and *Sebacina*, the nearly resupinate genus *Eichleriella*, and use *Exidiopsis*, with altered meaning, as a section of *Sebacina*. Since they dealt only with the hymenomycetes of France, the genera *Heterochaete*, chiefly tropical in range, and *Stypella*, thus far reported only from the Americas, were not treated. Neuhoff (Arkiv Bot. **28 A**: 27–34. 1936) follows Bourdot and Galzin in his treatment of the Tremellales of Sweden. In this country, Burt (Ann. Missouri Bot. Gard. **2**: 749–766. 1915; **13**: 334–339. 1926) and Rogers (Univ. Iowa Stud. Nat. Hist. **15**: 9–13. 1933; **17**: 37–43. 1935) criticize the practice of erecting a genus on the basis of a single distinctive hymenial character, and retain *Bourdotia* and *Heterochaetella* as subgenera for gloeocystidiate and cystidiate forms of *Sebacina*.

The lack of agreement which exists in taxonomic treatments of *Sebacina* at present can be attributed to certain problems which must be solved before a natural arrangement can be achieved. Probably the foremost of these is the need for a clear delimitation of natural genera in the Tremellaceae; and, if *Sebacina* in the sense of Tulasne is to be considered a natural group, it must be distinguished clearly from nearly related genera which contain species approaching the effused, resupinate form. Secondly, definite criteria for generic segregation must be agreed upon, so that it may be decided whether *Sebacina* in the broad sense should be divided into separate genera. And thirdly, there is a profound need for complete specific diagnoses, which entails a careful study and redescription of type specimens of many species, especially but not exclusively those described in the nineteenth century, before the taxonomic importance of microscopic details was fully recognized.

It is my opinion that *Sebacina* in the broad sense can be clearly delimited from other genera on the basis of its resupinate, effused habit and indeterminate, closely adnate margin. *Stypella*, with its arachnoid superficial subiculum on which waxy or gelatinous pustulate swellings develop, seems to be clearly distinct from *Sebacina*, whose scattered, indeterminate patches, often becoming confluent, are not at any time visibly connected by such a superficial network. Other genera, at least as defined at present, may in certain forms superficially resemble *Sebacina*, but can almost

without exception be differentiated, even in apparently effused forms, by their thick, unattached margins. Whether *Eichleriella*, *Exidia*, *Tremella*, etc., are natural groups is perhaps to be questioned, but certainly they possess more highly differentiated fructifications than do *Stypella* or *Sebacina*.

The great variation in texture and hymenial structures of species embraced in *Sebacina* has led to several attempts to divide the group into separate genera. The lack of unanimity in accepting these attempts at segregation indicates forcibly the attitude of taxonomists in general toward the establishment of artificial groups on the basis of single distinctive characters.

The genus *Bourdotia*, erected by Bresadola to include forms of *Sebacina* possessing gloeocystidia, is not a homogeneous group. While the type species, *B. Galzinii*, and at least one other species are distinctly gelatinous, a great majority of the gloeocystidiate species are arid-waxy in texture. Careful study of microscopic structures reveals strong evidence that the arid species are part of a continuous transitional series from some arid form without gloeocystidia, perhaps similar to *Sebacina calcea*. A hint of relationship can be found, on the other hand, between the gelatinous members of *Bourdotia* and certain waxy-gelatinous species of *Sebacina*. It seems certain that more information must be available before the segregation of gloeocystidiate species of *Sebacina* as a natural genus can be justified.

Heterochaetella, erected by Bourdot and Galzin to receive species of *Sebacina* possessing true cystidia, is even more obviously an artificial group than *Bourdotia*. The three species commonly referred to this genus or the subgenus *Heterochaetella* are extremely unlike. *H. dubia*, the type species, is somewhat like the *Bourdotia* group in the tendency of its hyphae and mature basidia to disintegrate upon drying; it is like the soft gelatinous species of *Eusebacina* in consistency; and it has conspicuously thick-walled, blunt-tipped cystidia with dilated lumina, known elsewhere, to my knowledge, only in the genus *Peniophora*. *H. crystallina*, known to me only by description, must be closely related to, if not actually synonymous with *Stypella papillata* Möller. It is certainly not closely related to *H. dubia*. And *Sebacina sublilacina* Martin, technically referable to *Heterochaetella* if the presence of cystidia is to be considered a good generic criterion, appears to be much nearer certain of the thin gelatinous species of *Sebacina* than to either *H. dubia* or *H. crystallina*. *H. dubia* may even be sufficiently different from other resupinate Tremellaceae to justify the erection of a monotypic genus, but until further knowledge of what is described by Bourdot and Galzin (Hym. Fr. 52. 1928) as a highly variable group throws more light on the relationship of *H. dubia* to other resupinate forms, such a proposal seems premature. It is here suggested rather that *Heterochaetella* be retained as a section of *Sebacina*, to include

S. dubia and any other obviously related forms which may be discovered possessing cystidia of the type peculiar to this species. *S. sublilacina* and such other resupinate forms with little differentiated cystidia should be referred to the group without gloeocystidia or cystidia of the *S. dubia* type, to be known by the convenient name *Eusebacina* suggested by Rea (British Basid. 737. 1922). *Heterochaetella crystallina* should be excluded from the section *Heterochaetella*, perhaps temporarily placed in *Eusebacina;* but reexamination of the type will probably prove it to be a true *Stypella.*

Even *Eusebacina*, to which are referred those species lacking gloeocystidia or cystidia, or having cystidia only of an unspecialized type, cannot be said with certainty to constitute a homogeneous group. Two apparently distinct series of species can be distinguished. One, with marked development of an interwoven subiculum, represents a transition from gelatinous to tough coriaceous fructifications, terminating in the pileate genus *Tremellodendron.* Clamp connections in this series are lacking or extremely rare. Spores, basidia and habitat of the three species included here indicate close relationship. Another apparently closely related series is marked by gelatinous to waxy consistency, indistinct hyphae, and proliferation of fertile hyphae from a clamp connection at the base of each basidium. Other species, such as *Sebacina calcea*, seem to bear no obvious relationship to any others in the group, yet afford no criterion for their removal to any other genus now recognized.

I find no basis at present for the division of *Sebacina*, however heterogeneous the group may appear to be. There is some reason to suspect that *Sebacina* comprises a number of divergent lines of evolution, none of which has digressed far enough from a common ancestor or from the others to justify their segregation. On the other hand, it is quite probable that our inability to recognize the true relationships in the group is due simply to lack of sufficient information concerning these inconspicuous forms. Certainly, until much more is learned in regard to the affinities of the resupinate Tremellaceae, through further study and through discovery of probably numerous species as yet unknown, it seems better to retain the genus *Sebacina* (sensu Tulasne) intact. In this study it has been found convenient to divide the genus, until the true relationships of these resupinate forms become clear, into the three artificial sections: *Bourdotia* as originally defined by Bresadola, *Heterochaetella*, emended to receive only forms with cystidia like those of *S. dubia*, and *Eusebacina* for all other species referable to the genus.

Another difficult problem in the study of resupinate fungi is the selection of definite criteria for specific distinction. Probably the foremost reason for this is their lack of pileate fructifications of characteristic size and form, details of which are considered important in the identification of non-resupinate fungi.

Early mycologists relied almost entirely on external characters for the arrangement of fungi into taxonomic groups. Since resupinate organisms with hymenia of unspecialized configuration offered few obvious external characters, they were almost without exception referred to the single genus *Thelephora*. Tulasne (Ann. Sci. Nat. III. **19**: 193–231. 1853; V. **15**: 215–235. 1872; Jour. Linn. Soc. Bot. **13**: 31–42. 1871) was one of the first to recognize the importance of microscopic characters in the basidiomycetes, and with his establishment of the genus *Sebacina*, based on the possession of longitudinally septate basidia, the process of sorting the resupinate "Thelephoras" into more nearly natural groups as shown by microscopic structure began.

Earlier students of *Sebacina* persisted in stressing external characters, confining their study of microscopic details to basidium and spore size and the type of basidial septation. Brefeld (Untersuch. **7**: 94–95, pl. 6, figs. 22–26. 1888) with a knowledge of but one species, *S. incrustans*, attempted to establish the importance of a characteristic type of conidiophore as a basic structure for the genus, but his findings have never to my knowledge been verified in nature even for the one species.

More recent workers, recognizing the difficulty of identifying resupinate fungi by so few and variable characters, have tended to make their descriptions more and more detailed. Bourdot and Galzin give full, clear accounts of external characters, the complete range in size of hyphae, basidia, spores, and sterile hymenial elements; and add such valuable details as manner of spore germination, nature of the substratum, distribution, and growing season. They neglect, however, to make clear the spatial relations of separate elements of fructifications. Burt, the first American to study *Sebacina* extensively, stressed particularly the stratification and thickness of fructifications and the arrangement of the members of each stratum, as shown by thin transverse sections. He gives the sizes of hyphae, basidia, spores, and sterile hymenial organs, but the lack of variation indicated by his measurements suggests that few were made. Since many of the specimens examined by Burt had been collected long before, and since he studied chiefly coriaceous and more arid forms whose basidia commonly fail to revive on soaking after prolonged drying, measurements may in many cases have been of necessity limited in number and accuracy. As to the external appearance, Burt emphasized the color in the dry condition, with the remark that this is often the only color criterion available. Rogers and Coker present concise, clear descriptions similar to those of Bourdot and Galzin, with some attention to the stratification and arrangements of parts, after the fashion of Burt.

Size of fructifications in *Sebacina*, except as a very general character, is of little significance, since all forms known are indeterminate in growth. Some species may be distinguished by differences in size when those dif-

ferences are great, but no definite size can be cited for any species.

Color in the fresh condition, although often widely variable within a species, is of value in certain forms if one is careful to distinguish between actual color of the organism and that of the substratum or underlying organisms. Color in the dried condition, considered quite constant by Burt, is of use in coriaceous or corticioid forms which remain plainly visible upon drying. Color is never so constant, however, as to justify the keying out of species on the basis of color alone, as was done by Burt.

Consistency of the fructification when moist, especially when fresh, may often be of use in a general way. Such terms as soft gelatinous, cartilaginous, mucous, waxy, coriaceous, and fleshy are fairly clear in meaning, though difficult to define exactly. It must be remembered, however, that gelatinous or waxy consistency may vary with moisture conditions; and the hydrophilic capacity decreases upon prolonged drying in the herbarium.

Surface variations, if carefully observed, are significant in a few species. Such irregularities as tuberculose or undulate contour, for instance, may hint of the origin of a fructification by confluence of separate pustules. The occurrence of characteristic tooth-like projections is in one form at present referred to the section *Bourdotia* an obvious specific character. It is my experience, however, that nearly all of the species referred to *Sebacina* because of the resupinate, adnate, indeterminate nature of their fructifications, often described as tuberculose or undulate, are typically smooth unless modified by irregularities of their substrata.

Thickness, stressed by Burt, is of little significance in *Sebacina* except in a general way. Some species have conspicuous subicula of varying thickness; others may or may not have distinct subicula, varying with the age of the fructification. All forms studied have hymenia which increase in thickness by repeated proliferation of the fertile hyphae and growth of sterile elements, apparently as long as conditions are favorable for growth. Some species obviously renew this growth during each favorable period throughout the specific growing seasons to which they are adapted. Rather wide variation in thickness is therefore common throughout the group.

Shape and size of basidia are constant enough to be of much use in identification in the Tremellaceae. Basidial form is fairly constant within a species, but volume seems to be more constant than the length and breadth dimensions. Also of importance is the manner in which basidia are borne. In all the species studied, basidia are borne apically on erect fertile hyphae which proliferate from the bases of the basidia to form new basidium-bearing stalks or sterile branches. The manner of proliferation, whether from clamp connections or not, whether branched or unbranched, is a usable and rather constant character.

Spore size and shape are of considerable use in specific determination.

Size of spores varies more than most other microscopic characters because of the common occurrence of secondary spore formation and frequent production of only two or three spores from a basidium. Yet, if the average size of all but the obviously gigantic or dwarf spores is considered, size is usually quite uniform in a single collection. This criterion must be used with caution, however, since some variation does occur between different collections. Spore shape is more constant than size, since the secondary spores take the same shape as that of primary spores. Spore form is sometimes almost completely diagnostic.

Sterile hymenial elements may be of much importance in identification. Diameter and branching of paraphyses are often distinctive. More important still is their position, arrangement, and the extent of their emergence beyond the basidia. Cystidia, apparently rare in the Tremellaceae, are good specific characters if described clearly as to shape, size and extent of emergence. The anomalous type of cystidium in *Heterochaetella dubia* is a distinctive character and is strongly suggestive of a phylogenetic divergence sufficient for generic distinction. Gloeocystidia, as yet poorly defined structures, occur in such widely scattered groups that they can hardly be of significance except as specific characters. Their size is so variable within a species, varying apparently with the age of fructifications, that only their presence or absence, color and origin are worth consideration as taxonomic characters.

Stratification of fructifications, considered of prime importance by Burt, is helpful in the determination of certain species, especially the coriaceous and fleshy forms. But here again, too great reliance on the presence or absence of a distinct subiculum is dangerous. All species commonly referred to *Sebacina* have a subiculum sometimes almost lacking, sometimes rather thick. In several species, the thickness of the subiculum varies with the age of the fructification; in others young stages are apparently homogeneous, without subicula, while their older fructifications or older parts of the same one have thick layers of heavy-walled, subcoriaceous hyphae somewhat similar to those in the extremely coriaceous forms. As a result, young collections dry to hyaline vernicose films; older specimens of the same species may dry to conspicuous corticioid crusts, thinner but otherwise similar to the coriaceous crusts of *S. helvelloides* and *S. incrustans*. The often-mentioned character of separability of fructifications seems to be due to the presence of loosely woven subicula which split easily, rather than to lack of attachment to the substrata.

From the above discussion it becomes evident that no single character is completely adequate for the identification of a resupinate tremellaceous fungus. For that reason it is necessary to make judicious use of all possible characters which show any degree of constancy at all. The entire assemblage of external and internal characters, however variable individually,

should lead to an accurate determination, assuming of course that a complete description is available upon which to base the determination. Unfortunately, many original diagnoses scattered through the literature are so lacking in detail and accuracy as to be almost meaningless. Until the type specimens described in this way can be reexamined and redescribed, their sole effect upon taxonomic mycology is to create confusion. Undoubtedly much synonymy exists at present because of inadequate diagnoses published in widely scattered periodicals, their type specimens unavailable for examination.

It has been my aim in the present study to fill a need for complete descriptions of carefully identified specimens representing all available species of resupinate members of the Tremellaceae occurring in temperate North America. The number of species treated probably lacks much of being complete, but it is hoped that the list may include a sufficient number of forms to be of use. The specimens studied represent collections in the University of Iowa mycological herbarium, including specimens from widely scattered parts of the United States, Canada, and Mexico; authentic specimens from European herbaria, used for identification of American collections; specimens from the Missouri Botanical Garden, the New York Botanical Garden, and the Farlow Herbarium of Harvard University; and numerous specimens collected in Iowa during the past decade by Professor G. W. Martin and his students. Specific descriptions in most cases include variations observed in several collections. An attempt has been made to combine the descriptive methods of Bourdot and Galzin and of Burt, since each stressed characters which the other neglected. Because of the confusion experienced in identification of specimens from incomplete descriptions, I have chosen to risk the criticism of over-completeness rather than succumb to the all-too-common practice of brevity to the point of vagueness.

In the critical study of specimens, the methods described by Burt were followed rather closely. After a thorough study of the external gross characters of fructifications under a binocular microscope, thin transverse sections of the fresh or resoaked specimens were placed on a slide, moistened with alcohol, drained, flooded with 3% KOH solution, stained with 2% aqueous phloxine, drained to remove excess stain, reflooded with KOH and covered with a thin cover glass. The general structure in section was studied at magnifications of 100 to 600 diameters after which measurements were made at ×900.

Basidial dimensions in specific descriptions refer always to mature hypobasidia, the presence of longitudinal septa or of epibasidia serving as criteria of maturity. Where three figures are used to describe a single dimension, the middle figure indicates the approximate average while the other two denote the extremes in variation which were observed. Figures in

parentheses indicate rare extremes in variation. In description of color, the nomenclature is that of Ridgway except where the terms used are obviously intended as mere approximations.

It will be evident to readers that much use has been made of the publications of other students of *Sebacina*, notably those of Bourdot and Galzin, Burt, Coker, Rogers, and Martin during the course of this study. I wish to extend my sincere thanks to Dr. J. M. Greenman and Dr. C. W. Dodge of the Missouri Botanical Garden and to Dr. D. H. Linder of the Farlow Herbarium for their many courtesies as well as for the privilege of studying specimens in their care. Much credit is due also to Dr. H. S. Jackson of the University of Toronto, Dr. Fred J. Seaver of the New York Botanical Garden and Dr. D. P. Rogers of Oregon State College, specimens from whom have made possible the study of material representing a wide range of territory in North America.

And finally, for his encouragement, interest, and kindly criticism, especial thanks are extended to Professor G. W. Martin, under whose direction this study was made in the mycological laboratories of the department of Botany of the State University of Iowa.

Sebacina Tul., Jour. Linn. Soc. Bot. **13**: 35. 1871.

Fructification resupinate or incrusting, often with scattered free projections of variable form; varying in texture from tough-coriaceous to gelatinous or waxy; arising in indeterminate patches which often become confluent, but margins always thinning out and closely adnate; hymenium smooth to undulate, rarely borne on short granular columns; basidia borne in a distinct hymenium, becoming longitudinally septate into two to four cells, each cell typically bearing a tubular epibasidium, sometimes nearly suppressed, at the apex of which a sterigma and spore is developed; basidiospores smooth, suballantoid, ovate, globose or cylindrical, hyaline, pale yellowish or violaceous, germinating by repetition or by germ tubes. Type, *Thelephora incrustans* Pers. ex Fries.

Distinguished from *Stypella* by the effused rather than interrupted fructification, the hymenium borne on a continuous flat subiculum instead of on an arachnoid network. Unlike *Eichleriella*, *Exidia*, and *Tremella* in its gradually thinning, indeterminate, adnate margin, although some forms of *Eichleriella* are very close to arid forms of *Sebacina*. Differentiated from *Heterochaete* by the presence in the latter of peg-like protuberances composed of clusters of sterile hyphae, and from *Protodontia* and *Protohydnum* by their fertile teeth.

The genus is here divided for convenience into three sections, an arrangement which is probably unnatural, but which seems the most satisfactory one until the phylogenetic relations of the group are better known.

Key to Sections

Neither gloeocystidia nor highly differentiated cystidia present............I. Eusebacina p. 11
Thick-walled, bristle-like cystidia with apically dilated lumina present...II. Heterochaetella p. 12
Without cystidia, but possessing gloeocystidia with yellow or brown contents at maturity....
....III. Bourdotia p. 12

Key to Species

I. Eusebacina

a. Fleshy to tough coriaceous, growing on forest humus and associated litter, or incrusting bases of trees and herbaceous plants..b
a. Soft gelatinous, waxy gelatinous, fleshy or arid, growing on soil or dead wood..............c
  b. Fleshy—coriaceous, white to warm buff, sometimes with free lobes; basidia imbedded in a layer of densely interwoven hyphae..................................1. *S. incrustans*
  b. Coriaceous, hymenium ochraceous-tawny to purplish brown; basidia scattered in a palisade layer of simple paraphyses...2. *S. helvelloides*
c. Spores broadly ovate or obovate to globose...d
c. Spores subcylindric, cylindric, allantoid, or subulate..................................g
  d. Growing on the ground or decayed wood, thick, gelatinous, whitish to gray; basidia immersed in a palisade layer of slender, simple or little-branched paraphyses; clamp connections lacking..3. *S. epigaea*
  d. Growing on wood; grayish-hyaline to hyaline; clamp connections present at bases of basidia; paraphyses branched, distinct or more or less gelatinized...........................e
e. Waxy-gelatinous, gray, drying to a hyaline or whitish-vernicose crust; spores broadly ovate, mostly 9–12×6–9µ..4. *S. molybdea*
e. Soft gelatinous, pale grayish-hyaline to hyaline, spores smaller, ovate, obovate, or globose....f
  f. Pale grayish-hyaline; spores ovate to obovate, mostly 7–9×4.5–6.5µ..........5. *S. opalea*
  f. Hyaline, thin, spores subglobose, 4–6×4–5µ.........................6. *S. sphaerospora*
g. Spores more than four times as long as broad..h
g. Spores less than four times as long as broad...i
  h. Spores cylindric to suballantoid, 18–20×3.5–4µ.........................7. *S. prolifera*
  h. Spores subulate, flexuous, often laterally apiculate, 18–34×3.5–5µ.........8. *S. calospora*
i. Arid-waxy to fleshy, drying to a plainly visible opaque crust, white, brown, or fuscous, never vernicose; without calcareous nodules..j
i. Waxy-gelatinous to soft gelatinous, grayish-hyaline, drying vernicose, brown, hyaline, or invisible; calcareous granules present or absent...k
  j. Thin, arid, pulverulent, forming small anastomosing patches; spores cylindric-curved, 18–22×7–9µ..9. *S. calcea*
  j. Fleshy, widely effused, cartridge buff to dull brown; drying to a parchment-like crust; spores allantoid, 10–13×4–5µ...10. *S. adusta*
k. Soft-gelatinous, hyaline or very pale grayish-hyaline, evanescent on drying; spores allantoid, 5–8×2.5–3.5µ...15. *S. fugacissima*
k. Waxy-gelatinous, grayish-hyaline to lilaceous-gray, drying to a grayish, yellow, brown, or olivaceous crust..l
  l. Fructification gray, waxy-gelatinous, drying dark bluish-gray; spores cylindric, usually curved, mostly more than 12µ long...m
  l. Drying to a yellowish-brown to olivaceous crust; spores subcylindric to allantoid, mostly less than 12µ long..n
m. Mature probasidia obovate to ovate; spores mostly 13–16×4.5–6µ.......11. *S. plumbescens*
m. Mature probasidia almost exactly globose; spores mostly 15–19 (–24)×6.5–8µ....12. *S. atra*
  n. Pale bluish-gray to grayish-hyaline, drying to a yellow-brown or yellow vernicose crust, often with scattered calcareous nodules; spores subcylindric to allantoid, mostly 6–10×4–5µ
  ....13. *S. podlachica*
  n. Lilaceous-gray or gray, pruinose, drying to an inconspicuous olivaceous patch; hymenium with more or less thickly-scattered subulate thin-walled cystidia; spores 6–9×3–4µ......
  ....14. *S. sublilacina*

II. Heterochaetella

Thin, mucous-waxy, gray, with very thick-walled, bristle-like cystidia, their lumina dilated at the apices; spores obovate to lacrimate, 5–7×3.5–4.5μ. . . . . 16. *S. dubia*

III. Bourdotia

a. Fructification soft-gelatinous; basidia covered by a layer of bushy tipped paraphyses. . . . . . b
a. Fructification waxy to pruinose-reticulate; basidia at the surface; paraphyses few and indistinct or lacking. c
b. Gloeocystidia broadly clavate, with pale yellowish contents; spores allantoid, 10–13×4–5μ . . . . 17. *S. umbrina*
b. Gloeocystidia brown, slender; spores ovate to suballantoid, 10–14×5–7.5μ. . . 18. *S. Galzinii*
c. Spores ovate to oblong, sometimes with a minority varying to subglobose. . . . . d
c. Spores globose or subglobose. . . . . h
d. Spores large, mostly over 12μ long, subglobose if less. . . . . e
d. Spores mostly less than 12μ long. . . . . f
e. Fructification gray, arid-waxy; spores ovate-oblong, 16–22×8–11μ; gloeocystidia yellowish. . . . . 19. *S. pini*
e. Fructification floccose-rimose; spores elliptical to subglobose, 10–13.5×8–11μ; gloeocystidia brownish. . . . . 20. *S. rimosa*
f. Hymenium with peg-like teeth; spores often wider than long, 3.5–4×3μ. . . . . 25. *S. grandinioides*
f. Hymenium smooth or pruinose-reticulate. . . . . g
g. Spores broadly ovate to subcylindric, 7–12×5–8μ. . . . . 21. *S. cinerea*
g. Spores oblong or elliptical to subglobose, 4.5–6.5×3.5–5μ. . . . . 22. *S. deminuta*
h. Spores subglobose to elliptical, 10–13.5×8–11μ. . . . . 20. *S. rimosa*
h. Spores much smaller, globose. i
i. Fructification pruinose-reticulate to continuous, waxy, whitish to ochraceous-tawny; spores minutely apiculate, 4–6.5μ in diameter. . . . . 23. *S. Eyrei*
i. Fructification pruinose-reticulate; white to pale-gray; spores 5–7.5μ in diameter, with prominent peg-like apiculi. . . . . 24. *S. caesio-cinerea*

1. SEBACINA INCRUSTANS (Fr.) Tul., Jour. Linn. Soc. Bot. **13**: 36. 1871.

Plates 1, Fig. 1; 2, Figs. 7–9.

Thelephora incrustans Fr., Syst. Myc. **1**: 448. 1821.
Thelephora cristata Fr., Syst. Myc. **1**: 434. 1821.
Thelephora sebacea Pers., Myc. Eur. **1**: 135. 1822.
Corticium sebaceum (Pers.) Massee, Jour. Linn. Soc. Bot. **27**: 127. 1890.
Sebacina laciniata [Bull.] Bres., Ann. Myc. **1**: 116. 1903.
?*Sebacina Amesii* Lloyd, Myc. Writ. **5**: 576. 1916.
Sebacina cristata (Fr.) Lloyd, Myc. Writ. **7**: 1361. 1925.

Fleshy to tough-coriaceous, resupinate, growing over the ground and forest litter, often forming small subulate to subpileate projections, usually with fimbriate tips, frequently ascending and incrusting grass, bases of herbaceous stems, shrubs and trees, rarely appearing as rosettes of free, flattened branches with lobed and fimbriate margins, spreading in radiate fashion, horizontally unless supported by vegetation, from one point of origin in forest litter, and very rarely arising as a small irregular pileate mass; in section 200–1000μ thick, sometimes more, with a thick spongy subiculum of loosely interwoven hyphae 2–3 (–4)μ in diameter, yellowish, without clamp connections, arranged in more or less ascending strands, becoming densely interwoven in the upper part and giving rise to a hy-

menium 80–170μ thick, composed of tortuous, branched, ascending, interlaced paraphyses 1.5–3μ in diameter, with basidia scattered throughout, the young uncollapsed ones in the upper part, borne terminally on erect fertile hyphae which proliferate by a lateral branch at the base of each basidium without clamp-formation; probasidia ovate, conspicuously guttulate, yellowish, 13.5–15–20 $\times$ 10–12–15μ at maturity, becoming longitudinally septate into four cells, each bearing a flexuous epibasidium 2.5–3μ in diameter, variable in length in proportion to the distance of the hypobasidium from the surface; spores subcylindric to broadly ovate, flattened on one side, 10–13 (–15) $\times$ 6–7.5μ, germinating by repetition.

On ground and incrusting moss, grass, debris, and bases of living or dead herbaceous stems, shrubs and trees. Nova Scotia and Quebec south to South Carolina, west to Minnesota, Iowa, and Louisiana. Probably common throughout the United States. July to October.

This species is remarkable for its variability in form. More commonly it appears as a resupinate incrustation over soil, debris, and bases of small erect objects, although small fimbriate projections from the surface are not rare. Infrequently, however, it appears as a rosette of pileate lobes, very much as illustrated by Bulliard (Champ. Fr. **4**: pl. 415) for *Clavaria laciniata*, except that the lobes are more dependent on surrounding debris or vegetation for support than as shown in Bulliard's figure. One collection is at hand in which the fructification is in the form of an irregular substipitate mass 1.5 cm. in diameter. Lloyd described a new species as *S. Amesii*, which is probably an unusually thick fructification of *S. incrustans* growing over and filling the interspaces between moss plants (Myc. Writ. **5**: 576, figs. 810, 813. 1916; 756, fig. 1130. 1918).

TYPE LOCALITY: Europe.

ILLUSTRATION: Bulliard, Champ. Fr. **4**: pl. 415, fig. a. 1809; Berkeley, Outl. British fungol., pl. 17, fig. 6. 1860; Tulasne, Ann. Sci. Nat. V. **15**: pl. 10, figs. 6–10. 1872; Brefeld, Untersuch. **7**: pl. 6, fig. 22 (non 23, 24. 1888; Patouillard, Essai Tax. 25, fig. 17 a, d. 1900; Burt, Ann. Missouri Bot. Gard. **2**: pl. 27, fig. 13. 1915; Lloyd, Myc. Writ. **5**: fig. 1115. 1917; **5**: fig. 810. 1916; **5**: fig. 1130. 1918; **7**: fig. 3238, 3239, 3241. 1925; Neuhoff, Arkiv för Botanik **28 A**: pl. 6. 1936.

SPECIMENS EXAMINED: Iowa: Numerous collections; Massachusetts: Canton. D. P. Rogers 566; North Carolina: Bryson City. L. R. Hesler and A. J. Sharp. August 23, 1936. Ex herb. Univ. Tennessee; Tennessee: Elkmont. L. R. Hesler. Univ. Tennessee herb. 11827; England: Sussex. Sept. 29, 1932. E. M. Wakefield; Gloucestershire. Oct. 14, 1936. E. M. Wakefield, Ex Kew herb

2. SEBACINA HELVELLOIDES (Schw.) Burt, Ann. Missouri Bot. Gard. 2: 756. 1915.

Plates 1, Fig. 2; 2, Figs. 10–14.

Thelephora Helvelloides Schw., Naturforsch. Ges. Leipzig Schrift. **1**: 108. 1822.
Corticium basale Peck, New York State Mus. Rept. **43**: 23. 1890.
Corticium Helvelloides Massee, Jour. Linn. Soc. Bot. **27**: 153. 1890.
Sebacina chlorascens Burt, Ann. Missouri Bot. Gard. **2**: 756. 1915.

Broadly effused, spongy-coriaceous, rarely with small fimbriate-tipped

free lobes; growing over moist soil and moss, often ascending and incrusting the bases of living trees and shrubs; sterile subiculum whitish to warm buff, with indeterminate margin; hymenium waxy, arising in patches, becoming confluent, finally covering large areas or the whole surface, warm buff or ochraceous tawny to deep purplish brown; fructification drying to a thick crust, sterile portions dingy buff, hymenium warm buff to Sanford's brown or fuscous; in section 250μ to 1.5 mm., rarely 5 mm. thick, with a broad basal portion of brownish, thick-walled hyphae 2.5–4μ in diameter, becoming more densely interwoven above, giving rise to a hymenium composed of a palisade-like layer 100–300μ thick of erect, simple or little-branched paraphyses 1.5–2.5μ in diameter, shorter and thicker in young fructifications, with basidia, borne on clampless hyphae, scattered loosely among the paraphyses from their bases to within 30–70μ of the surface; probasidia ovate, yellowish, conspicuously granular to guttulate, 15–17–22×10–15μ, becoming 4-celled by longitudinal division, each cell forming a long, straight epibasidium 2–3μ in diameter; spores broadly ovate to subcylindric, flattened on one side, guttulate, yellowish, 10–12–15 ×6–7.5–9.5μ, germinating by repetition, in one collection becoming transformed into irregular resting cells by the walling off of protoplasm in one portion of the spore. Probasidia sometimes transformed similarly before reaching maturity.

Incrusting soil and bases of deciduous trees and shrubs, August to October. New York and Ontario south to Florida, west to Iowa. Probably widespread and commonly identified as *S. incrustans*.

This species is widely variable in color and spore characters, but is readily identified by the coarse brownish hyphae of the subiculum and the palisade layer of slender paraphyses. Burt described the basidia as 20–25 ×15μ, which is scarcely proportional to the spore size he gives of 12–13 ×6μ. In collections which I have examined in the fresh condition, mature probasidia rarely exceed 20×15μ. Since the mature basidia of this species rarely revive after prolonged drying, it is essential that they be measured soon after collection. The questionable measurements published by Burt may have been due to the fact that his material, collected by Schweinitz and Peck, was very old.

Sebacina chlorascens Burt is scarcely to be recognized as a separate species simply on the basis of free pileate lobes when all other characters are identical with those of *S. helvelloides*. This complete argeement in stratification, basidium and spore characters and habitat is rather to be considered an indication that *Sebacina helvelloides* in certain conditions forms free lobes similar to those of *S. incrustans*. This is not surprising since the two species are obviously closely related. The differences between *S. helvelloides* and *S. chlorascens* in basidium and spore size were not corroborated in examination of the types.

PLATE I

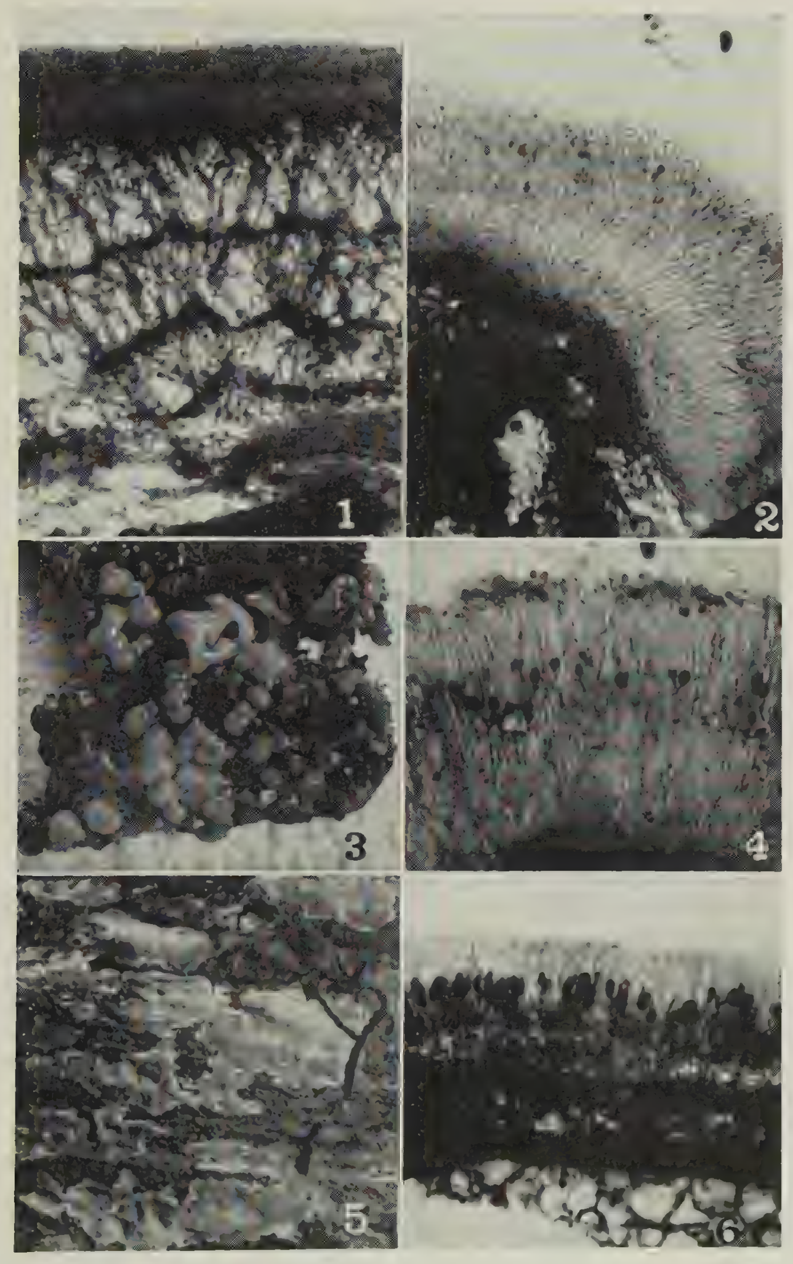


Fig. 1. *Sebacina incrustans*, transverse section, ×68; 2, *S. helvelloides*, transverse section, ×115; 3, *S. epigaea*, habit, ×5; 4, *S. epigaea*, transverse section, ×170; 5, *S. calcea*, habit, ×5; 6, *S. calcea*, transverse section, ×133.

Lloyd (Myc. Writ. **5**: 779. fig. 1174. 1918) described as a new species *Sebacina spongiosa*, which is probably the purplish form of *S. helvelloides*.

TYPE LOCALITY: North Carolina.

ILLUSTRATIONS: Burt, Ann. Missouri Bot. Gard. **2**: pl. 27, figs. 14, 15; 756, text fig. 1. 1915.

SPECIMENS EXAMINED: Iowa: Numerous collections; Ontario: Rondeau Park, Univ. Toronto 6775. H. S. Jackson; New Hampshire: Chocorua. W. G. Farlow. Ex Missouri Bot. Gard. 9992; New York: New York City. F. S. Earle. Ex Missouri Bot. Gard. 61350; North Carolina: Highlands. L. R. Hesler and G. W. Martin. G. W. Martin 1391d. Transylvania County. W. A. Murrill and H. D. House. Ex Missouri Bot. Gard. 57339; Florida: Cocoanut Grove. *Sebacina chlorascens* Burt, type. R. Thaxter 98. Ex Missouri Bot. Gard. 43923; Pennsylvania: Meadville. L. O. Overholts 8146. Ex Missouri Bot. Gard. 59359; Indiana: Scottsburg. J. R. Weir 20019. Ex Missouri Bot. Gard. 59169.

3. SEBACINA EPIGAEA (Berk. & Br.) Bourd. & Galz., Hym. Fr. 39. 1928.

Plates 1, Figs. 3–4; 2, Figs. 15–21.

Tremella epigaea Berk. & Br., Ann. Mag. Nat. Hist. II. **2**: 266. 1848.
?Sebacina ambigua Bres., Ann. Myc. **1**: 116. 1903.
Sebacina atrata Burt, Ann. Missouri Bot. Gard. **2**: 765. 1915.
Sebacina Cokeri Burt, Ann. Missouri Bot. Gard. **13**: 334. 1926.

Soft-gelatinous to cartilaginous, white to grayish-hyaline, arising in small indeterminate patches which expand and by confluence form rather thick interrupted to continuous undulate-tuberculate fructifications on soil, bases of living trees, and the lower sides of very rotten logs, adnate, margins indeterminate to somewhat abrupt; drying to a hyaline or yellowish-brown vernicose film, often pruinose; in section 150–500μ thick, with a thick basal region of distinct, hyaline, loosely interwoven hyphae, without clamp connections, 1.5–2.5μ in diameter, giving rise to a hymenium of erect fertile hyphae 2–3μ in diameter, bearing basidia in a zone varying with age up to 70μ wide, and a palisade-like layer of erect simple to little-branched paraphyses 1.5–2μ in diameter, rising 40–80μ above the basidia, frequently with short spur-like branches near the tips, bearing minute granules; probasidia at first clavate, often tapering to a blunt point, finally ovate, conspicuously granular or guttulate, 14–16–19$\times$10–12–14μ, becoming 4-celled by longitudinal division, each cell bearing a tubular epibasidium 1.5–2.5μ in diameter, up to 100μ long, the tips expanded, rarely bearing two sterigmata, only one of which functions; spores obovate to broadly ovate, unilaterally flattened, guttulate, 8–11–13.5$\times$6–8 (–10)μ, germinating by repetition or a stout germ tube, or frequently becoming transformed into angular thick-walled resting cells with several hyaline subulate projections.

On soil, bark at the bases of living trees, and the lower sides of deciduous logs. One collection reported on *Pinus*. Ontario to North Carolina, west to Iowa, Missouri and Oregon. Common in autumn, July to October.

No significant differences could be found between the original descriptions of *Sebacina epigaea* and *S. ambigua* except for the habitats, the one on soil, the other on wood. This is scarcely of sufficient significance to justify

the maintenance of separate species, for the soil inhabiting form appears only on soil so rich in organic matter as to be little different from rotten wood as a substratum. A difference in color might be inferred from the descriptions, but I have examined both gray and white fructifications which were collected on wood. One collection from soil was white in some parts and gray in others. The grayish color when present is probably chiefly that of the substratum, for the fructifications themselves, except when pruinose, are practically hyaline.

The pustulate origin, with confluence to form interrupted or undulate effused gelatinous sheets, and the striking palisade layer of slender paraphyses is common to both soil and wood-inhabiting forms.

Examination of the type specimen of *Sebacina Cokeri* shows it to be identical with *S. epigaea*. The spores are almost exclusively transformed into angular spiculate resting cells.

Three collections of *Sebacina atrata* Burt in the herbarium of the Missouri Botanical Garden and the type specimen in the Burt collection, Farlow Herbarium, are in no way distinct from *S. epigaea*.

Whelden (Mycologia **27**: 503–520. 1935) has described and illustrated the cytology of this species.

TYPE LOCALITY: England.

ILLUSTRATIONS: Burt, Ann. Missouri Bot. Gard. **2**: 766, fig. 7. 1915; Coker, Jour. Elisha Mitchell Soc. **35**: pl. 47; pl. 61, figs. 1–5. 1920; Bourd. & Galz., Hym. Fr. 40, fig. 19. 1928; Whelden, Mycologia **27**: 512, fig. 3. 1935.

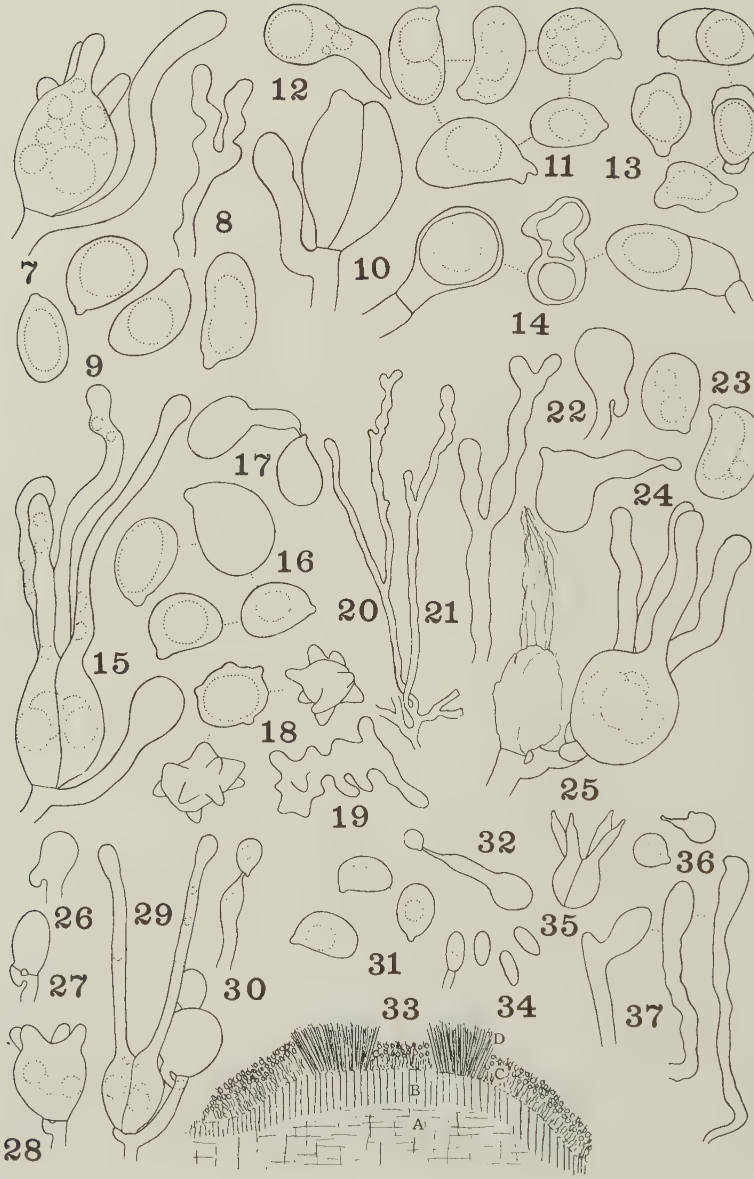
SPECIMENS EXAMINED: Iowa: Numerous collections; Nova Scotia: Upper Brookside. L. E. Wehmeyer 1062; Ontario: S. Aurora. Univ. Toronto 7183. Lake Temagami. Univ. Toronto 8500; New Hampshire: Chocorua. Missouri Bot. Gard. 44782, 55271, 55272, as *S. atrata* Burt; Massachusetts: W. G. Farlow. April 11, 1903, as *S. atrata*, type. Burt collection, Farlow Herb.; New York: Seventh Lake, Adirondacks. R. F. Cain 3278; North Carolina: Chapel Hill. Missouri Bot. Gard. 56719. W. C. Coker 4116, as *S. Cokeri* Burt, type; Missouri: Springfield. D. P. Rogers 325; Oregon: Cascadia. D. P. Rogers 379, 380, 402.

4. **Sebacina molybdea** sp. nov.

Plate 2, Figs. 22–25.

Late effusa, indeterminata, adnata, levis, ceraceo-gelatinosa, hyalino-grisea vel plumbea, sicca evanida, vernicosa hyalina usque fulva, vel crustata albida, lutea, usque fusca; in sectione 80–600μ crassa, hyphae noduloso-septatae, in inferiore parte indistinctae, a substrato vel subiculo laxe intertexto e distinctis noduloso-sepatitis hyphis 2.5–4μ diametro ascendentes; hymenium 50–70μ crassum, fertiles hyphae tortuae, ramum fertilem ex ansa base cuiusque basidi proponentes; basidia obovata vel subglobosa, guttulata, 11.5–13.5–16$\times$10–13.5–15μ, in zona 30–50μ lata, 10–30μ immersa; paraphyses tortuae, parum ramosae, subdistinctae vel omnino conglutinatae; sporae late ovatae vel subglobosae, uno latere depressae, plerumque guttulatae, 9–10.5–13.5$\times$6–7.5–8.5μ, per repetitionem germinantes.

PLATE II



Sebacina incrustans

7. Basidium, with fertile proliferation from base.—8. Apical portion of paraphysis.—9. Basidiospores.

Sebacina helvelloides

10. Hypobasidium, with fertile proliferation.—11. Basidiospores.—12. Spore germinating by

Very widely effused, waxy-gelatinous, pale grayish-hyaline to deep gull gray, usually pruinose, closely adnate, margin indeterminate; varying when dry from an invisible or very inconspicuous hyaline to ochraceous film to a conspicuous corticioid crust, whitish or buff to fuscous; in section 80–600μ thick, the hyphae bearing numerous clamp connections, indistinct in the lower part, ascending from the substratum or, in thicker portions, from a loosely interwoven subiculum varying up to 300μ thick, composed of distinct, clamp-bearing hyphae 2.5–4μ in diameter, sometimes pale yellowish in color; hymenium 50–70μ thick, composed of subdistinct, erect, fertile hyphae 2–3μ in diameter, proliferating from a clamp at the base of each basidium, the basidia in a densely packed zone 30–50μ thick, immersed 10–30μ in a layer of subdistinct to completely gelatinized, tortuous, little-branched paraphyses 2–3μ in diameter; probasidia obovate to subglobose, conspicuously guttulate, 11.5–13.5–16 (–18) $\times$ 10–13–15μ, becoming 4-celled by longitudinal division; epibasidia flexuous, 2–3μ in diameter, 20–70μ long, expanded at the tip, rarely forming two sterigmata at a single tip; spores broadly ovate, varying to subglobose or subcylindric, usually somewhat flattened on one side, guttulate, 9–10.5–13.5 $\times$ 6–7.5–8.5μ, germinating by repetition.

On the lower sides of logs of *Quercus* and *Populus*. Reported only from Iowa; common in early spring and in autumn.

The fructifications of this species form conspicuous gray gelatinous

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repetition.—13. Spores becoming transformed into resting cells.—14. Probasidia becoming similarly metamorphosed.

Sebacina epigaea

15. Basidium, with fertile proliferation.—16. Basidiospores.—17. Spore germinating by repetition.—18. Angular resting cells formed from spores.—19. Body formed in the hymenium, probably by transformation of a probasidium.—20. Paraphyses, $\times$490.—21. Tip of paraphysis, $\times$1000.

Sebacina molybdea

22. Probasidium with lateral hook.—23. Basidiospores.—24. Spore germinating by repetition.—25. Basidia, one empty and collapsed, the other nearly mature.

Sebacina opalea

26. Probasidium with lateral hook.—27. Probasidium with basal clamp.—28. Hypobasidium.—29. Basidium with probasidia borne on successive proliferations from basal clamp connections.—30. Tip of epibasidium, bearing sterigma and spore.—31. Basidiospores.—32. Spore germinating by repetition.—33. Diagrammatic section of fructification, showing (a) wood substratum, (b) stratum formed by fructification of previous season, (c) effused perfect stage of young fructification, and (d) conidiophores.—34. Conidia, one still attached.

Sebacina sphaerospora

35. Mature basidium.—36. Basidiospores, one germinating by repetition.—37. Portions of paraphyses.

All figures drawn with the aid of camera lucida and reproduced at a magnification of $\times$1000, unless otherwise indicated.

sheets when fresh. About ten large collections were made on a single field trip in late April of 1939, some fructifications covering areas of more than a square foot. Numerous collections of past years were found in the herbarium awaiting identification, nearly all having been collected in April. Distinctive microscopic characters are the plump, often nearly globose spores and the globose basidia, both conspicuously guttulate.

It is surprising that such a conspicuous form has not been reported before, but no description could be found which seemed to be applicable. It is nearest *Sebacina opalea*, resembling it quite closely except that its basidia and spores are larger, its fertile hyphae, epibasidia and subicular hyphae coarser. The latter are somewhat thick-walled and yellowish, resulting in a corticioid appearance of those dried fructifications in which the subiculum is well developed.

SPECIMENS EXAMINED: North Liberty, Iowa. April 26, 1939. G. W. Martin 4664, type; numerous other collections, all in eastern Iowa.

5. SEBACINA OPALEA Bourd. & Galz., Bull. Soc. Myc. Fr. **39**: 262. 1924.

Plate 2, Figs. 26–34.

Effused, soft-gelatinous, pale grayish-hyaline, smooth to undulate, closely adnate, margin indeterminate, drying to a very inconspicuous hyaline to yellowish-hyaline vernicose film, often pruinose, sometimes evanescent; in section 20–300μ thick, composed of ascending hyphae indistinct in the lower part, fertile hyphae becoming more distinct in outer portion, tortuous, 1.5–2μ in diameter, proliferating from clamp connections with prominent loops at the bases of young basidia; hymenium consisting of fertile hyphae, bearing basidia crowded in a zone 30–70μ wide at the surface, and indistinct paraphyses, not emergent; thicker fructifications developing a subiculum of distinct hyphae 1.5–3μ in diameter, arranged parallel with the substratum and bearing numerous clamp connections; probasidia obovate to subglobose, 9–11–13$\times$7.9μ, becoming tardily 4-celled by longitudinal division; epibasidia slender, flexuous, 1–2μ in diameter, up to 45μ long; spores obovate, lacrimate or broadly ovate, guttulate, obliquely apiculate, 6–9$\times$4.5–6μ, germinating by repetition; very young fructifications sometimes interrupted by pulvinate clusters up to 100μ thick and 500μ in lateral extent of erect unbranched conidiophores, cutting off terminal conidia, narrowly elliptical or cylindrical, 4–6$\times$1.5–2.5μ, apparently a stage of *Sebacina opalea*, later covered over by the effused perfect stage.

On decaying deciduous wood. Iowa, New York. March to November. Not rare, but inconspicuous and seldom collected.

Our Iowa collections agree closely in every detail with the original description and with a collection communicated to Burt by Bourdot, labelled "*S. opalea*, n. sp." *S. opalea* is distinguished from *S. podlachica* by its

mucous-gelatinous rather than waxy texture, its ovate or obovate spores in contrast to the subcylindric to allantoid spores of *S. podlachica*, its stalkless probasidia with prominent hooks which develop into conspicuous loops, and the extremely fine paraphyses, usually indistinct.

TYPE LOCALITY: France.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 42, fig. 21. 1928.

SPECIMENS EXAMINED: Iowa: Five collections; Ontario: Univ. Toronto 8501. H. S. Jackson; France: Galzin 16938. Dec. 24, 1914. Burt collection, Farlow Herbarium.

6. SEBACINA SPHAEROSPORA Bourd. & Galz., Bull. Soc. Myc. Fr. **39**: 263. 1924.

Plate 2, Figs. 35–37.

Effused, very thin, indeterminate, waxy-gelatinous, very pale grayish-hyaline to completely hyaline, scarcely visible; evanescent or drying to a pruinose hyaline vernicose film, barely visible under a lens; in section 25–85μ thick, with a basal layer of interwoven, agglutinated hyphae, or in thicker portions having a lacunate subiculum of hyaline agglutinated hyphae ascending in very loosely interwoven strands, on which is borne the interwoven layer, which in turn bears a dense hymenium 15–25μ thick, composed of almost completely agglutinated hyphae, the basidia, apical portions of fertile hyphae and occasional paraphyses only distinct; paraphyses filiform to clavate, sparsely branched near the tips, 1.5–3.5 (–5.5)μ in diameter at the apices; probasidia at first obovate, finally subglobose, becoming 4-celled by longitudinal division, guttulate, 7–8.5 $\times$ 6–7μ; epibasidia straight, subulate, divergent, 6.5–14 $\times$ 1.5μ; spores subglobose, guttulate, 4.5–5 $\times$ 4–5μ, germinating by repetition.

On sodden, very rotten *Quercus*, *Alnus*, *Pseudotsuga*, *Pinus*. Massachusetts, Oregon. November to April. Throughout the year in Europe.

A very inconspicuous species, marked by a strong tendency of all hyphae to become agglutinated into a structureless mass, but easily identified by spore shape and size. Probably close to *S. sublilacina* and *S. opalea*.

TYPE LOCALITY: France.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 43, fig. 22. 1928.

SPECIMENS EXAMINED: Massachusetts: Canton. D. P. Rogers. Nov. 16, 1936. Medford. D. H. Linder. Ex herb. D. P. Rogers; Oregon: Benton County. D. P. Rogers 573, 574, 575; Sweden: Seth Lundell 1192. Ex herb. D. P. Rogers.

7. SEBACINA PROLIFERA Rogers, Mycologia **28**: 350. 1936.

Plate 3, Figs. 38–40.

Fructification effused, very thin, mucous-gelatinous, hyaline, drying to a colorless vernicose film; in section 15–60μ thick, composed of an irregular basal layer of interwoven, thin-walled hyphae 1.5–2.5μ thick, with clamps at all septa, and a hymenium composed of erect fertile hyphae, bearing basidia apically and proliferating by a short fertile branch from a conspicu-

ous clamp connection at the base of each basidium; probasidia at first subglobose, finally ovate, 10 14×8–9μ, becoming 4-celled by longitudinal division; epibasidia 2–3μ in diameter, up to 20μ long; spores curved-cylindric, slightly attenuate at each end, 15–18–20×3.5–4 (–4.5)μ, germinating by repetition.

On the lower side of sodden decorticate deciduous wood. March, April, October. Reported only from Iowa City, Iowa.

S. prolifera is easily identified by its long, slender spores which taper markedly at each end and the oddly-broadened fertile hyphae at the base of each basidium. This species is apparently related to *S. calospora*, and is probably near the other clamp-bearing, thin, gelatinous species, *S. fugacissima* and *S. opalea*.

TYPE LOCALITY: Iowa City, Iowa.

ILLUSTRATION: Rogers, Mycologia **28**: 352, figs. 1–33; 357, fig. 34. 1936.

SPECIMENS EXAMINED: Iowa City, Iowa. D. P. Rogers 80, type; D. P. R. 525, 537, collected in the same locality.

8. SEBACINA CALOSPORA Bourd. & Galz., Hym. Fr. 46. 1928.

Plate 3, Figs. 41–43.

Exidiopsis calospora Bourd. & Galz., Bull. Soc. Myc. Fr. **39**: 263. 1924.

Effused over a very small area, extremely thin, waxy-gelatinous, hyaline to pale gray with a bluish or lilaceous tint, adnate, indeterminate, drying to an evanescent or faint grayish pruinose patch, barely visible under a lens; in section 15–50μ thick, with a thin basal layer of hyphae parallel with the substratum, from which rise short fertile hyphae 3–4.5μ in diameter, bearing basidia terminally and on a short lateral proliferation from a clamp connection at the base of each basidium; probasidia obovate to globose, 11–15×10–12μ, becoming 2–4-celled by longitudinal division; epibasidia 3–4μ in diameter, rarely up to 20μ long; spores fusiform, flexuous, often irregularly forked or with lateral spicules, 18–36×3.5–5 (–7)μ, germinating by repetition.

On rotten deciduous wood. April to November. Reported in North America only from Iowa. Collected in Europe on several species of deciduous wood, October to March.

S. calospora is a very inconspicuous species, rarely collected but easily recognized by its large oddly shaped spores, very similar to those of *Gloeotulasnella calospora* (Boud.) Rogers.

TYPE LOCALITY: France.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 46, fig. 23. 1928; Martin, Univ. Iowa Stud. Nat. Hist. **13** (5): 9, figs. 2–6. 1931.

SPECIMENS EXAMINED: Iowa: Iowa City. G. W. Martin. November 3, 1929. D. P. Rogers, April 21, 1932; North Liberty. D. P. Rogers 549; East Okoboji. D. P. Rogers 550.

9. SEBACINA CALCEA [Pers.] Bres., Fungi Trid. **2**: 64. 1892.

Plates 1, Figs. 5–6; 3, Figs. 46–49.

Thelephora calcea Pers., Myc. Eur. **1**: 153. 1822.
Thelephora acerina var. *Abietis* Fr., Syst. Myc. **1**: 453. 1821.
Thelephora calcea c. *albido-fuscescens*. Fr., Elench. Fung. **1**: 215. 1828.
Xerocarpus farinellus Karst., Finska Vet.-Soc. Bidrag. **37**: 139. 1882.
?*Sebacina Letendreana* Pat., Revue Myc. **7**: 152. 1885.
Corticium calceum Quél., Fl. Myc. Fr. 6. 1888.
Corticium Abietis (Fr.) Romell, Bot. Not. **1895**: 72.

Thin, resupinate, arid-waxy, closely adnate, grayish-white to ochraceous tawny, arising as minute pruinose patches which by confluence form an irregular subcontinuous crust, with us rarely larger than $5–6 \times 1$ cm., margin white, narrowly farinaceous; drying to a very thin, pulverulent, dingy whitish-gray to ochraceous-brown crust with white farinaceous margins; in section 50–160μ thick, with a subiculum varying from very thin to 100μ thick, composed of agglutinated hyphae parallel with the substratum, often containing a layer, rarely two layers of calcareous concretions which are stained by phloxine, and a hymenium consisting of basidia sparsely scattered in a narrow zone, borne terminally on short, erect, fertile hyphae 2–3μ in diameter, proliferating from a clamp connection at the base of each basidium, and paraphyses forming a layer 15–40 μ above the basidia, surrounded by a gelatinous matrix and bearing minute brownish granules; paraphyses of two kinds, some tortuous, 1–2μ thick, arising from the subiculum, others clavate, clamp-bearing, often sparsely branched, arising as proliferations from the bases of basidia, 2–3μ in diameter; probasidia at first oblong, hyaline, finally ovate to oblong or obovate, conspicuously granular-guttulate, 19–24 (–35) $\times$ 13–16.5μ, becoming 4-celled by longitudinal division; epibasidia cylindrical, 3–4μ thick, up to 50μ long; spores cylindric, granular-guttulate, unilaterally flattened or suballantoid, 15–18–22 $\times$ 7.5–9.5μ.

With us chiefly on dead wood of *Ulmus* and living or dead *Salix*. July to September. Rather uncommon.

Examination of collections from various herbaria determined as *Sebacina calcea* has revealed that nearly all of them are identical with *Eichleriella Leveilliana*, a form whose margins are at first indeterminate and farinaceous, finally becoming thickened and free from the substratum. Indeed, it seems probable, in view of his determinations, that Bresadola himself did not consistently distinguish between the two species. It is even possible that *Thelephora calcea* Pers., the type of *Sebacina calcea*, was a young fructification of *Eichleriella*, although the valid diagnosis (Myc. Eur. **1**: 153. 1822) suggests that it was not.

We have in Iowa a true *Sebacina* which seems clearly to fit the descriptions both of *Thelophora calcea* Pers. and *Sebacina calcea* (Pers.) Bres. It

is distinguished from *Eichleriella Leveilliana* by its thin, arid-waxy, dingy buff to tawny-ochraceous fructification with white farinaceous margins which never become thickened or free, in contrast to the fleshy-coriaceous, pinkish to dead white fructification of the latter, often with scattered calcareous tubercles, and with margins at first farinaceous, finally abrupt, thick, free and often reflexed. The paraphysoids of what I regard as *S. calcea* are of two types, fine, sinuous, little branched paraphyses loaded with granules, and clavate, clamp-bearing proliferations from the bases of basidia, both imbedded in a gelatinous matrix. Those of *E. Leveilliana* are of but one kind, thick, sometimes vesicular, with bushy tips heavily loaded with granules, and not surrounded by a gelatinous matrix. The basidia and spores of *S. calcea* are larger; and the subiculum is comparatively thin, gelatinized, containing large angular concretions which are stained by phloxine, while that of *E. Leveilliana* is, at maturity, thick, composed of distinct hyphae, yellow with minute granules which are not stained by phloxine. Fructifications of the species which I have identified as *S. calcea* form by confluence very small irregular patches rarely more than 5–6 × 1 cm., while those of *E. Leveilliana*, at first indeterminate, by confluence often cover areas several inches in length and width.

It is certain that the species which I call *S. calcea* is distinct from *E. Leveilliana*. It is also obvious that young fructifications of the latter, with indeterminate margins, were commonly identified as *S. calcea*, even by Bresadola and perhaps by Persoon. If the type, *Thelophora calcea*, is identical with *Eichleriella Leveilliana*, the species here regarded as *S. calcea* must be referred to a different species, probably *S. Letendreana* Pat. But if, as seems probable, the type was a true *Sebacina*, it seems likely that it was the same as our collections of *Sebacina calcea*. If this assumption is correct, this species is rather uncommon, very inconspiucous, and rarely collected; and the collections so identified in herbaria whose material I have studied are in reality *Eichleriella Leveilliana*, which is relatively common. Because of the evident confusion of these two species throughout the literature, it is impossible to give accurate geographical and host ranges until herbarium specimens determined as *S. calcea* can be reexamined. The synonymy here listed, excepting *S. Letendreana*, is that given by Bresadola and Burt. I suspect that several of these synonyms could more accurately be referred to *Eichleriella Leveilliana*, which admittedly is close to *Sebacina calcea* and would perhaps be as much at home in the genus *Sebacina* as in *Eichleriella*.

TYPE LOCALITY: Europe.

SPECIMENS EXAMINED: Iowa: Iowa City. Three collections. East Okoboji. Two collections; Illinois: Milan. E. B. Wittlake. October 16, 1937.

10. SEBACINA ADUSTA Burt, Ann. Missouri Bot. Gard. **2**: 764. 1915.

Plate 3, Figs. 44–45.

Broadly effused, ceraceous-fleshy, Hays brown in older portions, paling

to cartridge buff or white at the indeterminate margins; drying to a thin papery crust, fuscous to wood brown or drab, margins buff, fibrillose-fimbriate; in section 100–600μ thick, thinner portions consisting of a densely interwoven layer, filled with brown crystals, extending to the hymenium in the upper 60μ, which is made of indistinct ascending hyphae in the lower part and fertile hyphae 2.5–3μ in diameter, bearing basidia in a dense layer at the surface with short fertile proliferations arising from clamp connections at the bases of young probasidia; paraphyses few, not emergent, blunt, sometimes forked at the tips, 2–2.5μ in diameter, apparently arising as proliferations from fertile hyphae; probasidia at first clavate, finally obovate to ovate, 11–13.5–16 × 8.5–10μ, becoming tardily 4-celled by longitudinal division; epibasidia flexuous, 2–2.5μ in diameter, up to 20μ long; spores allantoid, guttulate, 11–13 × 4–5μ.

On dead decorticate *Populus*. Idaho, British Columbia. July to September.

This species is distinctive for its parchment-like crust on drying, its basidia borne at the surface, and its allantoid spores. It is not necessarily thick as described by Burt, and the separability which he emphasizes is due, as in several other species of *Sebacina*, to a subiculum of hyphae arranged parallel with the substratum, which splits easily or pulls apart from the more compact layers above. The fructification is actually closely adnate. I find the hyphae to be considerably agglutinated, so that the hymenium is difficult to crush out and the bundles of ascending hyphae refuse to separate.

TYPE LOCALITY: Idaho.

ILLUSTRATION: Burt, Ann. Missouri Bot. Gard. **2**: 764, fig. 5. 1915.

SPECIMENS EXAMINED: Idaho: Priest River. J. R. Weir 12, type. Burt collection, Farlow Herbarium; J. R. Weir 134. Ex Missouri Bot. Gard. 15756.

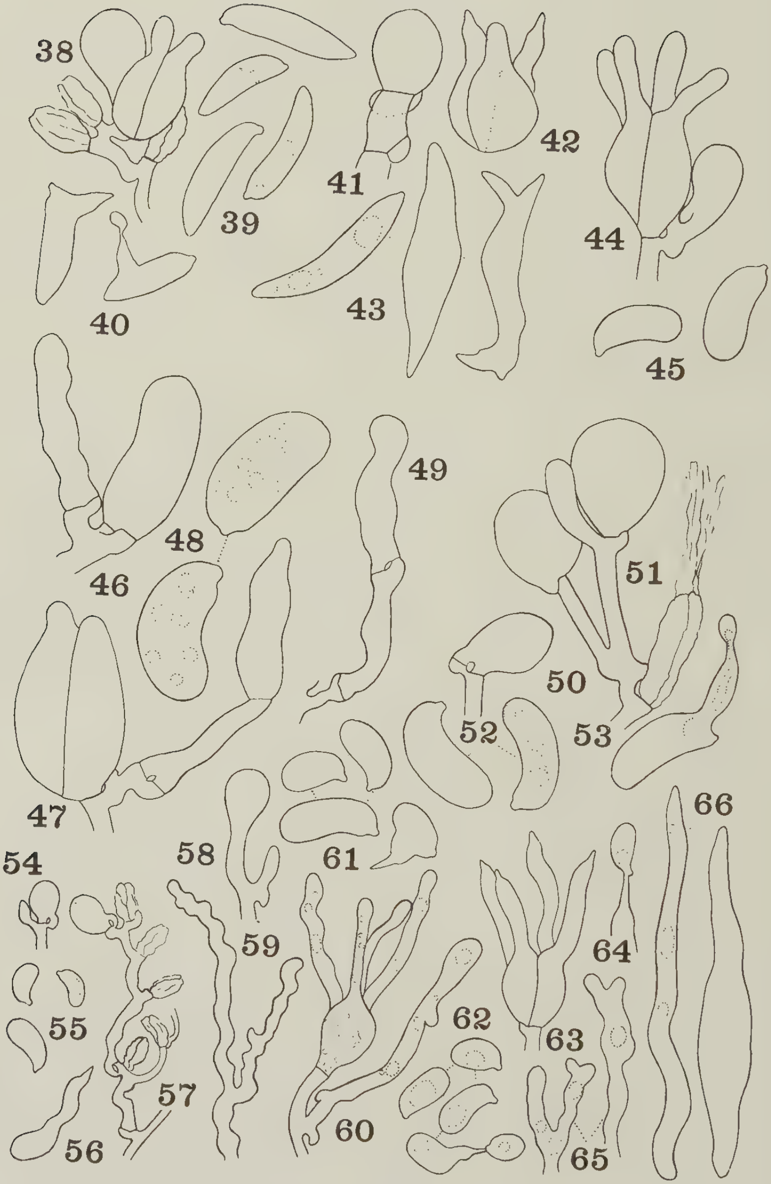
11. SEBACINA PLUMBESCENS Burt, Ann. Missouri Bot. Gard. **3**: 241. 1916.

Plate 3, Figs. 50–53.

Sebacina plumbea Burt, Ann. Missouri Bot. Gard. **2**: 765. 1915. Not *S. plumbea* Bres. & Torr.

Fructification effused, waxy-gelatinous, grayish-hyaline, indeterminate, drying to a very thin bluish-gray vernicose crust, heavily pruinose under a lens; in section 100–240μ thick, with a broad basal layer of loosely arranged, tortuous, ascending, subdistinct toruloid hyphae 1.5–2.5μ in diameter, arising from a very thin subiculum and bearing a hymenium 100–120μ thick, consisting of erect, much-branched fertile hyphae 2.5μ thick, proliferating by conspicuous clamp connections, basidia densely crowded in a layer 60μ wide and paraphyses 1–2μ thick, tortuous, tapering to 0.5μ toward the apices, their fine branches forming an interwoven layer 15–25μ thick above the basidia; probasidia at first obovate, finally broadly obovate, ovate, or subglobose, 14–17 × 11–13μ, becoming four-celled by longi-

PLATE III



Sebacina prolifera

38. Young, mature, and collapsed basidia, showing manner of proliferation from basal clamp connections.—39. Basidiospores.—40. Spores germinating by repetition.

Sebacina calospora

41. Probasidium, with basal clamp.—42. Mature basidium.—43. Basidiospores.

tudinal division; epibasidia 3μ thick, varying in length; spores allantoid, guttulate, minutely apiculate, 13–16.5 × (4.5–) 5–6μ, germinating by repetition.

On blackened *Populus trichocarpa*. Reported only from Washington. November.

TYPE LOCALITY: Bingen, Washington.

ILLUSTRATION: Burt, Ann. Missouri Bot. Gard. **2**: 765, fig. 6, 1915.

SPECIMEN EXAMINED: Washington: Bingen. W. N. Suksdorf 862, type. Burt collection, Farlow Herbarium.

12. **Sebacina atra** sp. nov.

Plate 4, Figs. 67–72.

Effusa, indeterminata, tenuior, adnata, mucoso-ceracea, plumbea, sicca subinvisibilis, subnigra, vernicosa; in sectione 50–100μ crassa, hyphae fertiles 2–3μ diametro, noduloso-septatae, a substrato ascendentes; basidia in densa zona 40μ crassa, 10–20μ submersa, primum obovata, demum subglobosa, in 2–4 cellas longitudinaliter divisa, 14–16.5 × 13.5–16μ; epibasidia 2.5μ diam., usque 40μ longa, 3.5–4.5μ diam. apicibus; sporae arcuato-cylindratae vel ellipticae, 14–19 (–24) × 6–9μ, per repetitionem germinantes.

Effused, thin, indeterminate, mucous-waxy, lead gray, drying to a dingy, dark gray, barely visible crust; in section 50–100μ thick, homogeneous, the fertile hyphae arising directly from the substratum, bearing basidia densely crowded in a zone 40μ wide, covered by a gelatinous layer 10–20μ thick con-

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Sebacina adusta

44. Basidium, with fertile proliferation from basal clamp.—45. Basidiospores.

Sebacina calcea

46. Probasidium, with basal clamp and clamp-bearing proliferation.—47. Mature hypobasidium, with proliferation.—48. Basidiospores.—49. Typical proliferation from clamp at base of basidium.

Sebacina plumbescens

50. Probasidium.—51. Probasidia, showing successive proliferations of fertile hypha.—52. Basidiospores.—53. Spore germinating by repetition.

Sebacina fugacissima

54. Probasidium, with basal clamp and fertile proliferation.—55. Basidiospores.—56. Spore germinating by repetition.—57. Fertile hypha, illustrating proliferation from clamp connections.

Sebacina podlachica

58. Probasidium, with young proliferation from incomplete basal clamp.—59. Portion of paraphysis.—60. Mature basidium with secondary basal septum above the clamp.—61. Basidiospores, one germinating by repetition.

Sebacina sublilacina

62. Basidiospores, one germinating by repetition.—63. Mature basidium.—64. Tip of epibasidium, bearing a sterigma and spore.—65. Apical portions of paraphyses.—66. Cystidia.

All figures drawn with the aid of camera lucida and reproduced at a magnification of ×1000.

taining numerous turgid and collapsed epibasidia and fertile branches; parphyses lacking or completely gelatinized; fertile hyphae 2–3μ in diameter, with numerous clamp connections with conspicuous loops and proliferating from a clamp connection at the base of each basidium; probasidia at first obovate, early forming a lateral hook which develops into the basal clamp, finally almost exactly globose, 14–16.5$\times$13.5–16μ, becoming 4-celled by longitudinal division; epibasidia 2.5μ in diameter, broadening to 3.5–4.5μ at the tips, up to 40μ long; spores cylindric-curved to elliptical, guttulate, 14–19 (–24)$\times$6–8 (–9)μ, germinating by repetition, the secondary spores shorter but no narrower, hence broadly ovate.

A single collection, on a sodden deciduous log. Iowa City, Iowa. March 17, 1933. Type.

13. SEBACINA PODLACHICA Bres., Ann. Myc. **1**: 117. 1903.

Plate 3, Figs. 58–61.

Effused, indeterminate, waxy-gelatinous, smooth to undulate, pale grayish-hyaline to bluish-gray, sometimes yellowish-hyaline on resoaking, usually with scattered calcareous granules, drying to a hyaline to plainly visible yellowish-brown (clay to Dresden brown, R) horny crust, the calcareous nodules becoming conspicuous, the margin narrowly farinose to fibrillose, white; in section 50–1000μ thick; thin fructifications composed of a narrow layer of densely woven, hyaline hyphae 2–2.5μ in diameter next to the substratum, a loose central layer 40–70μ thick of ascending, indistinct hyphae, and a hymenium of varying thickness, consisting of fertile hyphae 2–2.5μ thick, paraphyses, and basidia in a narrow zone near the surface; in thicker fructifications, a broad basal layer of brownish, thick-walled, clamp-bearing, loosely interwoven hyphae 2.5–3.5μ in diameter appears, and two or more successive hymenial layers may be present, the older ones more or less crushed and covered by later layers; paraphyses subdistinct, guttulate, erect, tortuous, sparingly forked near the broad apices, 2–2.5μ thick, forming a layer 5–20μ beyond the basidia; basidia borne terminally and on proliferations from clamps at primary septa some distance below the enlarged portions of young basidia; probasidia at first clavate, with basal septa and clamps 5–15μ below the swollen tips, tardily cut off by secondary septa at the bases of the swollen tips, finally obovate, conspicuously guttulate, yellowish-opaque, 8.5–11.5$\times$6–8μ, becoming longitudinally septate, two to four-celled; epibasidia sinuous, 1.5–2μ thick, 15–30μ long; spores obovate to cylindric, flattened on one side, usually somewhat curved, granular-guttulate, 6–8–10 (–13)$\times$4–5μ, germinating by repetition.

On decorticate deciduous wood, and reported once on coniferous wood. Massachusetts, Iowa. April to October.

The type collection is, as described by Burt, very thin, apparently a

young fructification. The very rare occurrence of little emergent subulate cystidia, too few to be relied upon as a taxonomic character, along with basidial and spore characters, hints of rather close relationship with *S. sublilacina*.

This species illustrates well the lack of reliability of color as a taxonomic character in the waxy or gelatinous fungi. Very thin fructifications, such as the type, dry to a hyaline, nearly invisible film. Older fructifications dry to a plainly visible, often conspicuous yellow-brown, rarely white or gray vernicose crust, usually with scattered calcareous nodules.

The great variation in basidium size cited by Bourdot and Galzin is probably due to the fact that the secondary basal septa are often very difficult to see. It may be that they sometimes fail even to develop, and in such cases the mature hypobasidium would be 5–15μ longer than in typical basidia. This would explain also the extreme variation in spore length in the type, but such variation has not been observed in our Iowa collections. The great majority of spores, both in the type specimen and in Iowa collections are much as described by Bresadola.

Until opportunity was found to study the type, much hesitance was felt in treating *S. podlachica*. Neuhoff (Arkiv Bot. **28 A**: 27–34. 1936), after examining the types of *S. podlachica* and *S. ambigua*, expressed doubt as to the distinctness of these two species and *S. opalea;* and stated that Bourdot had admitted doubt as to whether *S. opalea* and *S. podlachica* are different. Examination of the type of the latter and of an authentic collection of *S. opalea* which may be part of the type, reveals little reason for confusing the two species except for similarity in gross appearance. The spores of *S. podlachica* are mostly curved-cylindric and narrow; those of *S. opalea* are obovate to broadly ovate. The basidia of *S. podlachica* are stalked, with the basal septa and clamps far back along the stalk, later replaced by a secondary septum; while the young probasidia of *S. opalea* early form conspicuous hooks on their sides, the basal septa forming at the junction of broadened probasidium and fertile stalk. Fructifications of *S. opalea* may resemble young stages of *S. podlachica*, but never form opaque or turbid yellow-brown crusts on drying such as are typical of *S. podlachica*.

S. ambigua, with few or no clamp connections and much larger basidia and spores than *S. opalea* and *S. podlachica*, can certainly not be synonymous with either of the latter species. It is my opinion that *S. ambigua* is, instead, synonymous with *S. epigaea*, with which it apparently has every character in common except its habit on wood instead of on soil, a character whose significance is discussed under *S. epigaea*. It is certain, at any rate, that *S. podlachica* and *S. opalea* are distinct from each other; and it is equally certain that both are distinct from *S. ambigua*.

TYPE LOCALITY: Poland.

SPECIMENS EXAMINED: Iowa: Six collections; Poland: Type. Ex herb. Bres., in Burt collection, Farlow Herb.

14. SEBACINA SUBLILACINA Martin, Mycologia **26**: 262. 1934.

Plate 3, Figs. 62–66.

Effused, thin, waxy, pruinose, lilaceous-gray to pale grayish-hyaline, indeterminate, adnate, drying to an inconspicuous, sometimes barely visible olivaceous film, rarely with white calcareous nodules; in section 25–100μ thick, with a thin subiculum of hyphae parallel with the substratum, a layer of highly gelatinized, indistinct ascending hyphae, and a hymenium in the upper 20–50μ; basidia crowded in a narrow zone at the surface, borne on erect, subdistinct fertile hyphae which proliferate from a clamp connection at the base of each basidium; paraphyses simple to sparsely branched, tortuous, subdistinct, usually guttulate, 1.5–2.5–3.5μ thick at the tips, cystidia numerous to thinly scattered, subulate, thin-walled, 35–60×4–7μ, sometimes more slender, emerging 10–30μ; probasidia obovate to subglobose, conspicuously guttulate, 6.5–9–11×5.5–7.5–9μ, becoming longitudinally divided into 2–4 cells; epibasidia short, sinuous, 1.5–2.5μ thick, up to 10μ long, often guttulate, spores cylindric to ovate, flattened on one side, generally slightly curved, guttulate, (5–) 6–8 (–9)×3–4μ, germinating by repetition.

On very rotten deciduous wood, including *Populus*, *Quercus*, *Salix*, *Prunus*, *Ulmus*, and *Tilia*. Reported from Quebec, Ohio, Missouri, Iowa and Oregon. April to September. Common.

Distinguished from *S. fugacissima* by the presence of cystidia, larger spores, possession of paraphyses, more waxy consistency, and guttulate, hyphae, basidia and spores which cause an olivaceous color on drying. Apparently intermediate between the gelatinous, fugaceous forms and waxy species such as *S. podlachica*. When fresh, the fructification usually has a definite violaceous tint, as may the spores in mass. Easily recognized in the field by the color and pruinose appearance due to the emergent cystidia. The *Sebacina* which Whelden (Mycologia **27**: 503. 1935) studied and illustrated under the name of *S. fugacissima* is here treated as *S. sublilacina*, to which species Whelden's description and figures of spores, paraphyses, and cystidia clearly indicate it should be referred.

TYPE LOCALITY: Iowa City, Iowa.

ILLUSTRATIONS: Martin, Mycologia **26**: pl. 31, figs. 3–10. 1934: Whelden, Mycologia **27**: 508, fig. 2. 1935.

SPECIMENS EXAMINED: Iowa: Very numerous collections; Alberta: Edmonton. Irene Mounce. June 28, 1935; Missouri: Two collections. Big Spring. April 15, 1939; Oregon: Alsea Mt., Benton County. A. M. & D. P. Rogers; Quebec: Duchesnay. R. F. Cain 11128, 11132; New York; Seventh Lake. D. P. Rogers. 576; Massachusetts: Canton. D. P. Rogers 579; Medford. D. H. Linder. April 20, 1935; Ohio: Toledo. D. P. Rogers 577.

15. SEBACINA FUGACISSIMA Bourd. & Galz., Bull. Soc. Myc. Fr. **25**: 28. 1909.

Plate 3, Figs. 54–57.

Effused, gelatinous, hyaline, very thin, evanescent in drying; in section

60–70μ thick, with a thin basal layer of hyphae parallel with the substratum and a layer of loosely arranged erect fertile hyphae, 1–1.5μ in diameter, subdistinct, bearing numerous clamp connections, branching in the lower part, tortuous above because of lateral proliferation from a clamp at the base of each basidium, each stub bearing a collapsed basidium, young uncollapsed basidia crowded in a narrow zone at the surface; probasidia subglobose, hyaline, 5–6 × 4–5.5μ, becoming 2–4 celled by longitudinal division; epibasidia subulate to cylindrical, sinuous, up to 10μ long, 1–1.5μ thick; spores curved-cylindric, hyaline, 5–5.5 × 2.5–3.5μ, germinating by repetition.

On decorticate deciduous wood. Known in North America only from Iowa. July, October.

Three Iowa collections are referred to this species, which appears to be quite rare. While I have not seen authentic material, this species seems to differ from *S. sublilacina* in several respects, mentioned in discussion of the latter species. If our identification is correct, *S. fugacissima* is an extremely thin, effused mucous-gelatinous form, surely not synonymous with *Exidia Grilletii*, as stated by Neuhoff (Pilze Mitteleuropas. **2**: 44. 1936). The fungus which Whelden (Mycologia **27**: 503–520. 1935) studied and illustrated under the name *S. fugacissima* as identified by Martin, is almost certainly *S. sublilacina*, to which species I refer Whelden's excellent figures.

TYPE LOCALITY: France.

SPECIMENS EXAMINED: Iowa: Iowa City. G. W. Martin. October 3, 1934; D. P. Rogers 523. Nov. 5, 1934; West Okoboji. G. W. Martin. July 13, 1933.

16. SEBACINA DUBIA (Bourd. & Galz.) Bourd., Ass. Fr. Av. Sc. **45**: 576. 1922.

Plate 4, Figs. 73–74.

Heterochaete dubia Bourd. & Galz., Bull. Soc. Myc. Fr. **25**: 30. 1909.
Heterochaetella dubia Bourd. & Galz., Hym. Fr. 51. 1928.

Effused, thin, mucous-waxy, at first pruinose-reticulate, finally continuous, ochraceous-tawny, hispid under a lens, adnate, indeterminate; drying to a pale gray to dingy ochraceous crust, pruinose-hispid under a lens; in section 25–100μ thick, with a basal layer of indistinct hyphae parallel with the substratum, a central region of scattered, erect, indistinct hyphae, and a narrow hymenium of scattered subdistinct fertile hyphae 1.5–2μ thick, bearing basidia at the surface; cystidia conspicuous, thick-walled, blunt-tipped, bristle-like, with apically dilated lumina, straight or flexuous, 60–170 × 4–7 (–9)μ, arising from the subicular layer singly or in tufts and emergent up to 100μ; probasidia ovoid, 7.5–9 × 6–7.5μ, becoming 4-celled by longitudinal division; epibasidia subulate, short, spores obovate, lacrimate, or ovate, usually somewhat flattened on one side, guttulate, 5–7 × 3.5–4.5 (–5)μ, germinating by repetition.

On rotten coniferous wood. Iowa, Missouri, Oregon. October, Novem-

ber. Reported in Europe on deciduous wood also, throughout the year.

Unusual characters in this species are the distinctive thick walled cystidia of a type known only in the supposedly unrelated genus *Peniophora*, and the failure of basidia to revive, apparently due to their disintegration soon after drying.

The relationship of this species to the other resupinate Tremellaceae is very obscure. Only for that reason was it thought best to retain it in the genus *Sebacina* until enough is known about the whole group to enable us to achieve with some certainty a natural scheme of classification.

TYPE LOCALITY: France.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 52, fig. 30. 1928; Rogers, Univ. Iowa Stud. Nat. Hist. **15**: pl. 1, figs. 1–3. 1933.

SPECIMENS EXAMINED: Iowa: Luxemburg. D. P. Rogers 252; Oregon: D. P. Rogers 217, 554, 555, 580; Missouri: Springfield. A. M. Looney. October 2, 1933; Sweden: Upland. Seth Lundell 1180, 1191, 1195. Ex herb. D. P. Rogers; Austria: Tirol. V. Litschauer 37. August 24, 1928.

17. SEBACINA UMBRINA Rogers, Univ. Iowa Stud. Nat. Hist. **17**: 39. 1935.

Plate 4, Figs. 75–79.

Effused, waxy-gelatinous, mouse gray, varying to ochraceous-tawny and raw umber, with a narrow, white, indeterminate margin; drying vernicose, color unchanged, minutely granular, the margin finely radiate-fibrillose; in section 80–150μ thick, the basal portion of indistinct, gelatinized, obliquely ascending hyphae, and the outer 50–70μ composing a hymenium of distinct erect hyphae 2–3μ in diameter, appearing toruloid because of the crowded clamp connections, the fertile hyphae bearing basidia terminally, with numerous proliferations from basal clamps producing more basidia or becoming clavate paraphysoids 3–4.5μ thick, which put forth slender short-branched paraphyses from their tips; paraphyses slender, 1.5–2μ thick with antler-like apical branches emergent as a loose layer over the basidia, and clavate gloeocystidia with contents at first hyaline, finally pale yellow, granular, 25–50$\times$6–10μ; probasidia at first clavate, the basal clamp some distance back along the fertile stalk, finally obovate, cut off at the base of the broad distal portion by a second septum, 12–15$\times$8–10μ, becoming longitudinally septate, 4-celled; epibasidia flexuous, 20$\times$2.5–3μ; spores curved-cylindric, granular-guttulate, 10–13$\times$4–5μ.

On bark of dead branch of *Fraxinus*. A single collection. August.

A distinct species which despite the presence of gloeocystidia seems to be more closely linked with the waxy-gelatinous members of *Eusebacina* than with the arid forms of *Bourdotia*. Possibly a transitional form between *Eusebacina* and *Bourdotia*, or perhaps a member of a different line of evolution, showing parallelism with *Bourdotia* only in the possession of gloeocystidia. I am inclined to favor the latter view, but feel that a single scanty

collection is hardly sufficient material on which to base such a conclusion. *S. umbrina* is therefore retained in the section *Bourdotia*, where future collections can easily be identified by the plump, nearly colorless gloeocystidia and allantoid spores.

TYPE LOCALITY: West Okoboji, Iowa.
ILLUSTRATIONS: Rogers, Univ. Iowa Stud. Nat. Hist. 17: pl. 3, fig. 19. 1935.
SPECIMEN EXAMINED: Iowa: West Okoboji. D. P. Rogers 278. August 9, 1933. Type.

18. SEBACINA GALZINII Bres., Ann. Myc. 6: 46. 1908.

Plate 4, Figs. 80–82.

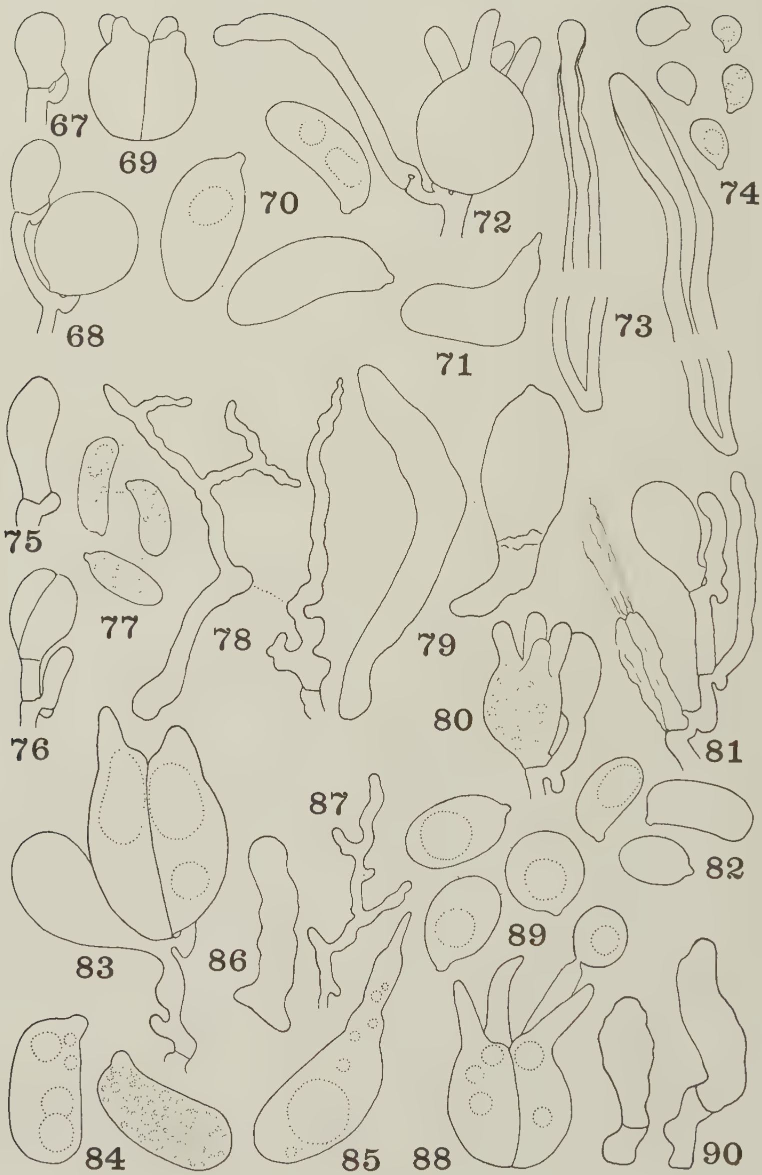
Bourdotia caesia Bres. & Torr., Broteria ser. bot. **11**: 88. 1913.
Sebacina lactescens Burt, Ann. Missouri Bot. Gard. **13**: 336. 1926.
Bourdotia Pululahuana (Pat. & Lagh.) Bourd. & Galz., subsp. *Galzini* (Bres.) Bourd. & Galz., subsp. *caesia* (Bres. & Torr) Bourd. & Galz., Hym. Fr. 48. 1928. Not *Tremella Pululahuana* Pat., Bull. Soc. Myc. Fr. **9**: 138. 1893.
Sebacina pululahuana (Pat.) Rogers, Univ. Iowa Stud. Nat. Hist. **17**: 38. 1938.

Effused, soft to waxy-gelatinous, hyaline to grayish-hyaline, often with scattered imbedded aggregate granules of calcareous material, margin indeterminate, adnate; drying to a blackish or dark brown vernicose crust; in section 80–300 (–1000)μ thick, composed of a basal layer of loosely interwoven gelatinized hyphae with numerous indistinct clamp connections, and a hymenial layer consisting of paraphyses, gloeocystidia, and erect fertile hyphae 2–3μ in diameter, bearing basidia terminally and on fertile proliferations from clamps at the bases of the basidia, the latter forming a loose layer near the surface; often composed of successive growth layers; paraphyses mostly thin, 1–2μ in diameter, with bushy tips composed of very fine tortuous branches, or sometimes subclavate, 2–4.5μ thick, simple or little branched, apparently abortive proliferations of fertile hyphae; gloeocystidia filiform to clavate, flexuous to tortuous, the apices often attenuate, rarely expanded, globose, contents at first hyaline, finally yellow or brown, 40–170 (–270) $\times$ 2.5–6 (–13)μ, arising from the subiculum or base of a new seasonal growth, often reaching the surface, sometimes extending through two or three successive growth strata, never emergent; probasidia at first clavate, finally obovate to ovate, guttulate, 13–19 (–24) $\times$ 8–10–13μ, becoming distinctly four-celled by longitudinal division; epibasidia cylindric, 2.5–3μ thick; spores cylindric to ovate, flattened on one side, often slightly curved, 10–13.5 $\times$ 5–7.5μ, germinating by repetition.

On rotten wood of various deciduous genera. Three collections from Iowa. Otherwise not reported from North America. July–August.

The type of *Tremella Pululahuana* Pat., generally assumed to be the basis of this species, is a thick, brown, tough-gelatinous fructification, composed of several growth layers. In the dry condition its appearance suggests that it was once subeffused, lobate, attached only by a limited surface, its margins thick, determinate and detached. In section, it obvi-

PLATE IV



Sebacina atra

67. Probasidium.—68. Probasidia, showing manner of proliferation.—69. Mature hypobasidium.—70. Basidiospores.—71. Spore germinating by repetition.—72. Nearly mature basidium and proliferation from basal clamp.

Sebacina dubia

73. Cystidia.—74. Basidiospores.

ously arose as separate convex pustules which expanded, became confluent in the second or third period of growth, and formed a continuous, rather smooth surface in the upper strata. It appears in section to have been attached to the substratum only at the original points of eruption. Because of its determinate margins, pustulate origin, lobate form and limited area of attachment, *Tremella Pululahuana*, collected in the tropics, is excluded from synonymy with the temperate form, *Sebacina Galzinii*. The latter, of which an authentic specimen was studied, is truly effused, closely adnate, indeterminate, and in section gives no indication of a pustulate origin. No differences in microscopic details beyond the limits of variability within a species were found; but I am of the opinion that difference in gross morphology is too great to justify the retention of these two forms in a single species or even in the same genus. It is perhaps significant that Patouillard described his collection as a *Tremella* (Bull. Soc. Myc. Fr. **9**: 138. 1893), although he also described new species of *Sebacina* in the same paper. The presence of gloeocystidia and the *Exidia*-like color and spore form suggest that *Tremella pululahuana* would be more at home in the genus *Seismosarca*, where it would be close to if not synonymous with *S. hydrophora* Cooke.

Our Iowa collections resemble the type of *Sebacina Galcinii* in every detail. Bourdot and Galzin are followed in including *Bourdotia caesia* as a synonym, and the inclusion of *Sebacina lactescens* Burt in the synonymy is based on a study of the type by Rogers.

TYPE LOCALITY: France.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 48, fig. 25. 1928; Rogers, Univ. Iowa Stud. Nat. Hist. **17**: pl. 3, fig. 17. 1935.

SPECIMENS EXAMINED: Iowa: Iowa City. G. W. Martin 1398, 1399. July 8, 1934. G. W. Martin. Aug. 6, 1936; France: Bourdot 2270. Ex Maire collection, Farlow Herbarium.

Sebacina umbrina

75. Probasidium.—76. Mature hypobasidium with secondary basal septum above the basal clamp connection.—77. Basidiospores.—78. Paraphyses.—79. Gloeocystidia.

Sebacina Galzinii

80. Basidium, with fertile proliferation.—81. Fertile hypha, bearing an empty collapsed basidium, a probasidium, and successive proliferations from basal clamps.—82. Basidiospores.

Sebacina pini

83. Mature hypobasidium, with fertile proliferation.—84. Basidiospores.—85. Spore germinating by repetition.—86. Gloeocystidium.—87. Portion of paraphysis.

Sebacina rimosa

88. Mature basidium, bearing one spore.—89. Basidiospores.—90. Gloeocystidia.

All figures drawn with the aid of camera lucida and reproduced at a magnification of $\times 1000$.

19. SEBACINA PINI Jackson & Martin, Mycologia **32**: 684. 1940.

Plate 4, Figs. 83–87.

Effused, arid-waxy, thin, smoke gray, drying to a thin pruinose crust, whitish to olive buff; margin indeterminate, farinaceous; in section 50–120μ thick, with a very thin subiculum along the substratum, from which rise gloeocystidia, paraphyses, and fertile erect hyphae 1.5μ in diameter; paraphyses slender, tortuous, short-branched, numerous, 1–2μ in diameter, arising from the subiculum and from clamp connections along the fertile hyphae, little emergent beyond the basidia; gloeocystidia very numerous, cylindric to subclavate, arising from the subiculum, 15–45 $\times$ 5–6μ, with contents at first hyaline, finally yellow; probasidia at first clavate, then obovate, finally suburniform, conspicuously guttulate, 22–25 $\times$ 18–22μ, becoming longitudinally divided into 4 cells; epibasidia short, divergent, subulate, up to 20μ long, 3–5μ thick at the base; sterigma very short; spores ovate to cylindric, flattened on one side, conspicuously guttulate, 16.5–22.5 $\times$ 8–11μ, germinating by repetition, commonly through the apiculus.

On *Pinus strobus*. A single collection. November.

This species is remarkable for its large basidia and spores and the slender fertile hyphae, tortuous because of repeated proliferation from clamp connections at the bases of basidia. *S. pini* is a typical member of the thin arid *Bourdotia* series, with the largest basidia and spores of all the species so far reported.

TYPE: Maple, Ontario. Nov. 6, 1938. H. S. Jackson. Univ. Toronto 13090.

20. SEBACINA RIMOSA Jackson & Martin, Mycologia **32**: 684. 1940.

Plate 4, Figs. 88–90.

Effused, arid-waxy, surface floccose-rimose, whitish; drying porous-reticulate, pallid to citrine drab; in section 35–70μ thick, with a thin basal subiculum of hyphae 1.5–2μ in diameter, with frequent clamp connections, and a hymenium consisting of gloeocystidia originating in the subiculum and of fertile hyphae, bearing both gloeocystidia and basidia; gloeocystidia cylindric to clavate, sometimes apparently septate, with contents at first hyaline, becoming brown, resinoid, fragile, 15–35 $\times$ 5–7.5μ; probasidia subglobose, 16–17 $\times$ 14.5–16μ, becoming urniform on production of subulate, divergent epibasidia up to 13μ long, 2.5–3μ thick at the base, conspicuously guttulate; spores subglobose to elliptical, guttulate, 10–12–13.5 $\times$ 8–11μ, germinating by repetition or by germ tubes.

On *Thuja occidentalis*. A single collection. November.

Easily identified by its large, unflattened spores, varying markedly in shape, and the large, nearly globose basidia, which become detached easily when nearly mature.

TYPE: Maple, Ontario. Nov. 13, 1938. H. S. Jackson. Univ. Toronto 13086.

21. SEBACINA CINEREA Bres., Fungi Trid. **2:** 99. 1892.

Plate 5, Figs. 91–94.

Exidiopsis cystidiophora Höhn., Ann. Myc. **3:** 323. 1905.
Sebacina murina Burt, Ann. Missouri Bot. Gard. **13:** 337. 1926.
Bourdotia cinerea (Bres.) Bourd. & Galz., Hym. Fr. 49. 1928.

Effused, thin, waxy, very minutely porous-reticulate to continuous, indeterminate, closely adnate, drying to a plainly visible cinereous or ochraceous-gray patch; in section 30–70 (–100)μ thick, the thicker portions with a granular appearing subiculum of agglutinated hyphae which is lacking in thinner parts, and a hymenium of erect fertile hyphae and gloeocystidia arising directly from the subiculum or substratum; gloeocystidia clavate to cylindric, often expanded to a globose apex, flexuous, thin-walled, sometimes incrusted, with contents at first hyaline, finally brownish, often fragmented, 15–25 (–60) $\times$ 4–7 (–9)μ; fertile branches erect, tortuous, 1–2μ in diameter, the immature basidia appearing clustered, borne terminally and on very short lateral proliferations from indistinct clamp connections at the base of each basidium, the clamps and fertile branches remaining as conspicuous stubs and thickenings along the sides of the columns and the collapsed basidial walls forming a cylindrical transparent sheath extending from the base to the probasidia at the apex; probasidia granular-opaque, obovate to ovate, 10–12–16.5 $\times$ 9–12–14μ, becoming 2–4-celled by longitudinal division; epibasidia subulate to cylindric, 8–15–25 $\times$ 3μ; spores oblong to broadly ovate, usually somewhat flattened on one side, guttulate, 7–11 (–13) $\times$ 5–8 (–9)μ, germinating by repetition.

On rotten decorticated deciduous and coniferous wood. Ontario, Iowa, Ohio, Mexico. Throughout the year.

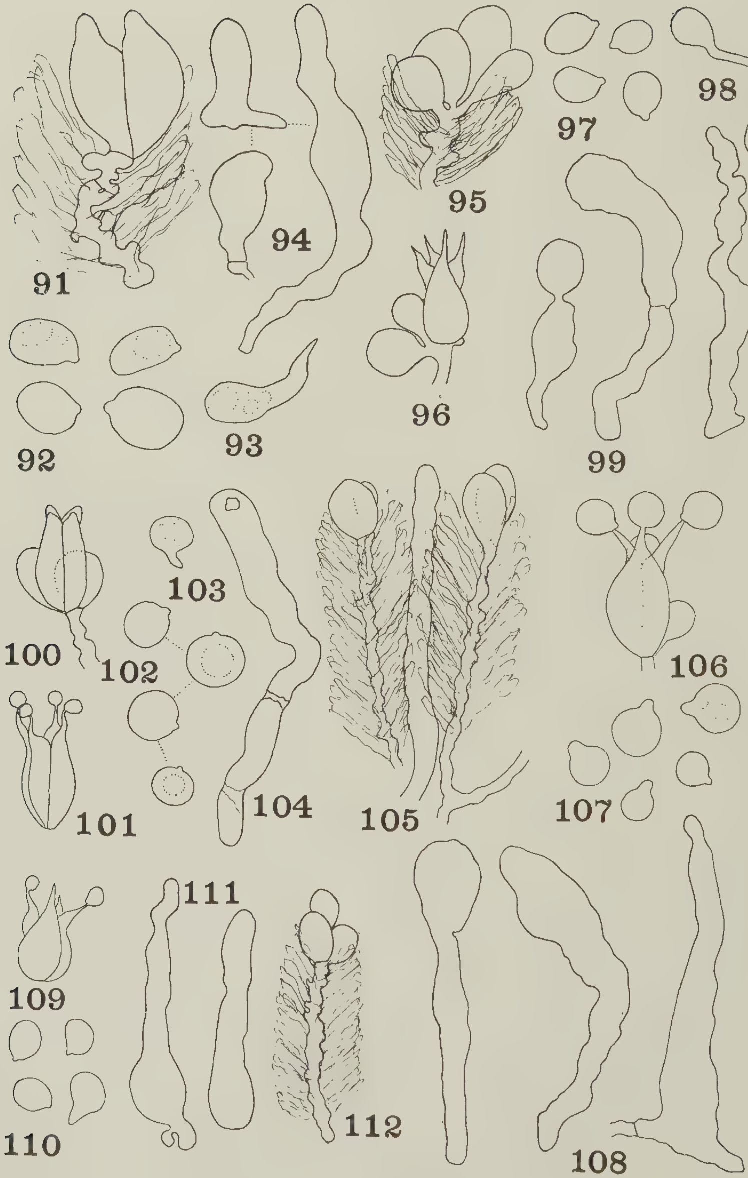
Thin fructifications are very similar to *S. caesio-cinerea* in external appearance, but are readily distinguished from that species by spore and basidium characters. The retention of the collapsed basidial walls as a sheath around an erect fertile column is characteristic of all the smaller arid members of the section *Bourdotia*. In the two forms with large basidia, *S. pini* and *S. rimosa*, as well as in *S. cinerea* to a lesser extent, there is a tendency for the basidia to become detached before spore discharge. In these forms also, the fertile proliferations are longer; hence the basidia are less crowded, so that the sheath of collapsed basidia tends to be less noticeable than in the forms with more compact structure.

TYPE LOCALITY: Tridentino, Italy.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 49, fig. 26. 1928; Rogers, Univ. Iowa Stud. Nat. Hist. **15:** pl. 1, figs. 4–6. 1933.

SPECIMENS EXAMINED: Iowa: Four collections; Ontario: Maple. D. H. Linder. May 5, 1936. Ex herb. D. P. Rogers. Deux Rivieres. G. W. Martin. Aug. 13, 1932. Bear Island, Lake Temagami. Univ. Ontario 11112; Ohio; Lorain County. F. O. Groves. D. P. Rogers 322; Oregon: Corvallis. D. P. Rogers 552. Comstock. D. P. Rogers 551. Benton County. D. P. Rogers 553; Mexico: Cordoba. *Sebacina murina* Burt, type. Ex Missouri Bot. Gard. 54603.

PLATE V



Sebacina cinerea

91. Fertile hypha, bearing a mature hypobasidium and sheath of collapsed basidial walls.—92. Basidiospores.—93. Spore germinating by repetition.—94. Gloeocystidia.

Sebacina deminuta

95. Fertile hypha bearing cluster of probasidia and sheath of collapsed basidia.—96. Mature basidium and probasidia.—97. Basidiospores.—98. Spore germinating by germ tube.—99. Gloeocystidia.

22. SEBACINA DEMINUTA Bourd., Ass. Fr. Av. Sci. **45:** 575. 1922.

Plate 5, Figs. 95–99.

Corticium involucrum Burt, Ann. Missouri Bot. Gard. **13:** 271. 1926.
Bourdotia deminuta (Bourd.) Bourd. & Galz., Hym. Fr. 50. 1928.

Pruinose-reticulate to continuous, effused, varying from pale gray through ochraceous-tawny to sorghum brown, pruinose, smooth to subtuberculate, adnate, indeterminate, drying to a grayish bloom, or in thicker fructifications to a continuous pruinose crust, cinnamon buff to wood brown; in section usually 20–40μ thick, sometimes thickened to 180μ by addition of successive layers, the hyphae mostly indistinct except for the erect fertile stalks and gloeocystidia arising in mixed clumps from a very thin subiculum; fertile hyphae 1.5–2.5μ in diameter, bearing apically 2–3 basidia in different stages of development, the short proliferations remaining as conspicuous stubs along the sides and the collapsed basidia forming a refractive sheath; probasidia at first obovate, finally ovate-urniform, 9–10.5–13 $\times$ 6–8μ, becoming 4-celled by longitudinal division; epibasidia subulate, 4–6μ long including the sterigmata; spores oblong or broadly elliptical to subglobose, flattened on one side, abruptly attenuate at the base, 4.5–6 $\times$ 3.5–5μ; gloeocystidia cylindric, flexuous, often constricted near the tips and expanded into globose heads above the constriction, contents at first hyaline, becoming brownish progressively from the base, the apical portion often hyaline, 12–40 (–55) $\times$ 4–6 (–9)μ.

On very rotten wood of deciduous trees; reported in Europe on *Pinus*. Ontario, Vermont, Massachusetts, Iowa, Oregon. March to November.

Rogers (Univ. Iowa Stud. Nat. Hist. **17:** 41–43. 1935) describes the proliferation of fertile hyphae and elongation of gloeocystidia in an account which probably applies equally well to all the *Bourdotia* group. Whelden (Mycologia **27:** 503–520. 1935) describes and illustrates the cytology of *S. deminuta*.

TYPE LOCALITY: France.

Sebacina Eyrei

100. Hypobasidium and probasidia.—101. Basidium bearing spores.—102. Basidiospores.—103. Spore germinating by repetition.—104. Gloeocystidium.—105. Fertile hyphae with apical probasidia and sheaths of collapsed basidia, and a gloeocystidium.

Sebacina caesio-cinerea

106. Basidium, bearing four spores and a hypobasidium. 107.—Basidiospores.—108. Gloeocystidia.

Sebacina grandinioides

109. Mature basidium bearing immature spores.—110. Basidiospores.—111. Gloeocystidia.—112. Fertile hypha, bearing three probasidia and a sheath of collapsed basidia.

All figures drawn with the aid of camera lucida and reproduced at a magnification of $\times$1000.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 50, fig. 28. 1928; Rogers, Univ. Iowa Stud. Nat. Hist. **15**: pl. 1, figs. 13–16. 1933; Whelden, Mycologia **27**: 506, fig. 1. 1935.

SPECIMENS EXAMINED: Iowa: Numerous collections; Ontario: Aurora. D. H. Linder. May 2, 1936. Ex herb. D. P. Rogers; Massachusetts: Jamaica Plain. G. D. Darker 4791. Ex herb. D. P. Rogers; Westwood. D. P. Rogers 547; Vermont: Middlebury. *Corticium involucrum* Burt, type. Ex Farlow Herbarium; Oregon: Heceta Beach, Lane County. D. P. Rogers 438; Cuba: Ceballos. C. J. Humphrey 2793. Ex Missouri Bot. Gard. 20200.

23. SEBACINA EYREI Wakef., Trans. British Myc. Soc. **5**: 126. 1915.

Plate 5, Figs. 100–105.

Gloeocystidium croceo-tingens Wakef., Ann. Myc. **18**: 48. 1920.
Bourdotia Eyrei (Wakef.) Bourd. & Galz., Hym. Fr. 50. 1928.

Pruinose-reticulate to effused, very thin, waxy, young fructifications whitish to gull gray, when older becoming pale cinnamon buff, pruinose, closely adnate, the margins thinning out or farinaceous, drying to a porous-reticulate or continuous, evanescent to plainly visible thin crust, varying in color from cinereous or light pinkish cinnamon to ochraceous-tawny; in section 50–150μ thick, fertile hyphae and gloeocystidia only distinct; fertile hyphae erect, tortuous, 1.5–2.5μ in diameter, arising almost directly from the substratum to the surface, with 2–3 basidia clustered at the apex and a sheath of collapsed basidia down the sides nearly to the base; gloeocystidia sinuous, subcylindric, with contents at first hyaline, later yellowish-brown, often fragmented, $15–50 \times 3.5–7\mu$, reaching the surface only in young fructifications, never emergent; probasidia at the surface, at first obovate, finally elongate-urniform, $8–11–13 \times 6–8\mu$, becoming indistinctly longitudinally septate, 2–4 celled; epibasidia at first divergent, then incurved, subulate, 5–9μ long; spores subglobose, minutely apiculate, hyaline or guttulate, 4–6.5μ in diameter, germinating by repetition.

On decaying wood or bark of deciduous trees and *Picea*. Quebec and Ontario to New Jersey, west to Ohio, Iowa and Oregon.

Sebacina Eyrei is very close to *S. deminuta*, and I have a strong suspicion that they are simply variations of the same species in response to different environmental conditions. The chief distinguishing character has been the difference in spore form, the spores of *S. Eyrei* having been described as globose, those of *S. deminuta* as oblong. I have examined several collections, determined as *S. Eyrei* whose spores are exactly globose or so broadened that the shortest axis runs through the apiculus. Numerous other collections, determined as *S. deminuta*, possess spores varying from oblong to broadly elliptical to almost exactly globose, the longest axis, however, running through the apiculus. The distinction between the two species is not only minute, but may simply be an arbitrary one, based on degree of turgidity rather than on a hereditary character. Examination of numerous specimens has revealed no constant difference in basidial form of collections with globose and those with oblong spores. Since I have not been able to examine the type of either species, however, I do not feel qualified to suggest at this time that the two species be combined.

S. Eyrei is distinguished from *S. caesio-cinerea* by its usually more elongate basidia and its smaller, minutely apiculate spores.

TYPE LOCALITY: England.

ILLUSTRATION: Rogers, Univ. Iowa Stud. Nat. Hist. **15:** pl. 1, figs. 7–9. 1933.

SPECIMENS EXAMINED: Iowa: One collection; Quebec: Jan. 1, 1935. I. Mounce; Ontario: Toronto. D. H. Linder and G. D. Darker. May 2, 1936. L. O. Overholts 18721. Univ. Toronto 9024; Massachusetts: Canton. D. P. Rogers 107. May 31, 1936; New York: Seventh Lake. D. P. Rogers 561. Sept. 12, 1935; New Jersey: Dias Creek. Sept. 10, 1932. G. W. Martin; Ohio: Wakeman. D. P. Rogers 333; Oregon: Reedsport. Oct. 22, 1938. D. P. Rogers 562. Corvallis. Oct. 15, 1939. D. P. Rogers 564; England: Alresford. W. Eyre. July 5, 1914. Co-type.

24. SEBACINA CAESIO-CINEREA (Höhn. & Litsch.) Rogers, Univ. Iowa Stud. Nat. Hist. **17:** 37. 1937.

Plate 5, Figs. 106–108.

Corticium caesio-cinereum Höhn. & Litsch., K. Akad. Wiss. Wien Sitzungsber. Math.-Naturw. Kl. I. **117:** 1116. 1908.
Gloeocystidium caesio-cinereum (Höhn. & Litsch.) Bourd. & Galz., Bull. Soc. Myc. Fr. **28:** 369. 1912.
Bourdotia cinerella Bourd. & Galz., Bull. Soc. Myc. Fr. **36:** 71. 1920.
Bourdotia caesio-cinerea (Höhn. & Litsch.) Bourd. & Galz., Hym. Fr. 261. 1928.
Sebacina cinerella (Bourd. & Galz.) Killerm., in Engl. & Pr., Nat. Pflanzenfam. 2 ed. **6:** 115. 1928.

Effused, waxy, thin, whitish to pale gray, appearing minutely porous-reticulate, almost continuous under a lens, drying to a pale gray patch, pruinose under a lens; in section 30–70 (–90)μ thick, in thinner portions the fertile hyphae and gloeocystidia rising directly from the substratum, in thicker portions rising from a subiculum up to 50μ thick of agglutinated hyphae; gloeocystidia cylindric-clavate, sinuous, often expanding apically into globose heads up to 15μ in diameter, 25–40 (–60)$\times$4–8 (–15)μ, with contents at first hyaline, soon brownish; fertile hyphae erect, tortuous, subdistinct, 1–1.5μ in diameter, each bearing 2–3 basidia at the apex and a sheath of collapsed basidial walls down the sides; probasidia at first obovate, finally ovate, hyaline, 10–13.5$\times$7.5–8.5μ, becoming tardily and indistinctly two to four-celled by longitudinal division; epibasidia subulate, 3μ thick at the base, 5–8μ long including the sterigmata; spores globose, 5–7.5μ in diameter, with peg-like apiculi 1–2μ long.

On very rotten wood of various deciduous species and *Pinus*. Quebec and Massachusetts to Iowa, Missouri and Oregon.

TYPE LOCALITY: Austria.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 49, fig. 27. 1928; Rogers, Univ. Iowa Stud. Nat. Hist. **15:** pl. 1, figs. 10–12. 1933.

SPECIMENS EXAMINED: Iowa: Iowa City. June 2, 1936. G. W. Martin. Luxemburg. D. P. Rogers 26; Quebec: Camp Donnacona, Stoneham. R. F. Cain 11131; Ontario: Lake Temagami. H. S. Jackson. Univ. Toronto 8498; Massachusetts: North Adams. D. H. Linder. Ex herb. D. P. Rogers; Missouri: Walnut Shade. A. M. Looney 5; Oregon: Alsea Mt., Benton County. D. P. Rogers 257. Heceta Beach, Lane County. D. P. Rogers 436. Philomath, Benton County. D. P. Rogers 563; Austria: Tirol. V. Litschauer 36; Sweden: Upland. Seth Lundell 1250. Ex herb. D. P. Rogers.

25. SEBACINA GRANDINIOIDES (Bourd. & Galz.) Rogers, Univ. Iowa Stud. Nat. Hist. **17**: 40. 1935.

Plate 5, Figs. 109–112.

Bourdotia grandinioides Bourd. & Galz., Hym. Fr. 51. 1928.

Fructification drying warm buff to cinnamon buff, pulverulent, under a lens appearing porous-reticulate, the strands radiating from and connecting blunt granular columns 40–100μ in diameter; columns composed of erect axes of parallel hyphae, from which arise radially gloeocystidia and fertile hyphae; gloeocystidia slender, subfusiform, ventricose, somewhat flexuous, blunt, filled with yellow, often fragmented contents, 30–50×4.5–6 (–8)μ; fertile hyphae 1.5–2μ in diameter, forming tortuous columns surrounded by sheaths of evacuated, collapsed basidial walls and bearing clusters of 2–3 young basidia at the apices; probasidia subglobose to suburniform, becoming longitudinally, often indistinctly septate, 6–8×4.5–5 (–6)μ; epibasidia at first divergent, finally incurved, subulate, about 3μ long; spores ellipsoid, with the shortest axis often through the minute apiculus, 3.5–4×3μ.

On magnolia. To date reported in North America only from New Jersey.

This species seems to have been reported only by Bourdot and Galzin, who described it among their "Formes insuffisament connues" (Hym. Fr. 31. 1928), and by Rogers (Univ. Iowa Stud. Nat. Hist. **17**: 40. 1935), who found two fragments in Exsiccati sets of Ellis and Everhart, labelled *Hydnum farinaceum* var. *luxurians* Cke.

TYPE LOCALITY: France.

ILLUSTRATIONS: Bourd. & Galz., Hym. Fr. 51, fig. 29. 1928; Rogers, Univ. Iowa Stud. Nat. Hist. **17**: 35, pl. 3, fig. 18. 1935.

SPECIMEN EXAMINED: Ellis and Everhart Fung. Col. 1017, ex herb. Oberlin College (fragment in State University of Iowa herbarium) as *Hydnum farinaceum* var. *luxurians* Cke.

SPECIES DUBIA

1. SEBACINA CINNAMOMEA Burt, Ann. Missouri Bot. Gard. **2**: 763. 1915.

The single specimen is immature. Margin abrupt, narrowly free. No spores and no structures certainly identifiable as basidia present. Not a *Sebacina*, and not even certainly a heterobasidiomycete.

SPECIMEN EXAMINED: Type. Burt collection, Farlow Herbarium.

SPECIES EXCLUDENDAE

1. SEBACINA MONTICOLA Burt, Ann. Missouri Bot. Gard. **2**: 761. 1915.

I find the type specimen to be in no way essentially different from *Eichleriella Leveilliana*. The paraphyses are perhaps less branched than usual, and the fructification is unusually heavily loaded with calcareous material. The basidia do not revive completely, but appear very similar to those of *E. Leveilliana* in form and size. The spore size indicated by Burt, if accurate,

might support a species distinction, but the dimensions which he gave do not appear proportionate to the basidial measurements. I found but one structure which may have been a partially collapsed spore; and it measured $12 \times 6\mu$, a size more nearly in proportion to that of the basidia. The condition of the specimen is such that it is difficult to be certain of its identity.

2. SEBACINA FIBRILLOSA Burt, Ann. Missouri Bot. Gard. **13**: 335. 1926.

A Peniophora in the sense of Burt or a Corticium as interpreted by Bourdot and Galzin. Basidia broadly clavate, $18–30 \times 9–10\mu$, without septa, and bearing short, curved sterigmata.

SPECIMEN EXAMINED: Missouri Bot. Gard. 54514, type.

3. SEBACINA AFRICANA Burt, Ann. Missouri Bot. Gard. **13**: 338. 1926.

A corticium with typical clavate, undivided basidia at the surface, and possessing hyaline, subulate gloeocystidia.

SPECIMEN EXAMINED: South Africa. P. A. van der Bijl 1342, type. Ex Burt collection, Farlow Herbarium.

4. SEBACINA POLYSCHISTA Berk. & Curt. ex Burt, Ann. Missouri Bot. Gard. **13**: 338. 1926.

Not a *Sebacina* and probably not a heterobasidiomycete. No longitudinally septate basidia could be found. This appears to be a "*Corticium*" with large hyaline gloeocystidia. No structures certainly identifiable as basidia could be made out, but basidiospores, ovate to elliptical, $12–14 \times 6–9\mu$, were plentiful, few reviving completely.

5. SEBACINA MACROSPORA (Ellis and Everhart) Burt, Ann. Missouri Bot. Gard. **2**: 759. 1915.

White, coriaceous, with free margins. To be referred to *Eichleriella Levielliana.*

SPECIMEN EXAMINED: *Sebacina macrospora* Burt, type. Burt collection, Farlow Herbarium.

6. SEBACINA (EXIDIOPSIS) LIVESCENS Bres., Fungi Trid. **2**: 64. 1892.

This species should probably be referred to the genus *Exidia*. The margins are thick, determinate, appressed, but not adnate. The species appears to be intermediate between *Sebacina* and *Exidia*, but in my judgment it is closer to the latter.

SPECIMENS EXAMINED: J. Bresadola. Aug. 6, 1897, type. Burt collection, Farlow Herbarium; Ostern, April, 1903. Ex v. Höhnel collection, Farlow Herbarium.

7. SEBACINA GLOBOSPORA Whelden, Rhodora **37**: 127. 1935.

A pustulate, thick, gelatinous, determinate form, adnate only at the point of eruption. To be referred to *Tremella*.

SPECIMEN EXAMINED: R. M. Whelden 333, type. Farlow Herbarium.

Undescribed Plants from Tropical America[1]

C. L. Lundell
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Piper Matudai sp. nov.

Frutex glaber. Folia petiolata, chartacea, lineari-lanceolata, apice attenuata, caudato-acuminata, basi subacuminata, triplinervia. Spicae oppositifoliae, 3–4 cm. longae (pedunculo incluso), usque ad 3 mm. diam.

A shrub, entirely glabrous; branchlets slender, the internodes often short, sometimes only 1 cm. long. Petioles canaliculate, usually 3 to 6 mm. long, those of lower leaves sometimes up to 1.3 cm. long. Leaf blades chartaceous, linear-lanceolate, 8 to 14 cm. long, 0.4 to 1.3 cm. wide, apex attenuate, caudate-acuminate, base subacuminate, decurrent, margin revolute, costa impressed above, prominent beneath, triplinerved or subtriplinerved, the secondary veins pinnate, inconspicuous. Spikes white, solitary, opposite the leaves, 3 to 4 cm. long (including peduncle up to 7 mm. long), up to 3 mm. in diam. (in fruit).

Mexico: Chiapas, along the Chacamax River at Palenque, July 10–12, 1939, *Eizi Matuda 3697* (type in the University of Michigan Herbarium).

The species is well marked by the long linear-lanceolate triplinerved leaves.

Piper usumacintense sp. nov.

Frutex, ramulis glabris, striatis. Folia petiolata, membranacea, glabra, late elliptica, apice obtusa vel abrupte subacuminata, acumine obtuso, basi inaequilateralia, acutiuscula, penninervia. Spicae oppositifoliae, usque ad 12 cm. longae (pedunculo incluso), 1.2 cm. diam.

A shrub, branchlets glabrous, striate, with internodes 3.5 to 7 cm. long. Petioles 1.1 to 2 cm. long, glabrous. Leaf blades membranaceous, very thin, at first with a few short hairs on the midvein beneath, otherwise entirely glabrous, broadly elliptic, 20 to 32 cm. long, 10.5 to 16 cm. wide, apex obtuse or abruptly subacuminate, the acumen obtuse, base unequal, each side rounded and acutish, pinnately veined, primary veins 10 to 12 on each side, the costa and veins most conspicuous beneath. Spikes solitary, opposite the leaves, up to 12 cm. long (including peduncle 1.5 to 2 cm. long), 1.2 cm. in diam. (in fruit).

Mexico: Tabasco, Boca del Cerro on the Usumacinta River above Tenosique, in advanced forest, July 1–5, 1939, *Eizi Matuda 3589* (type in the University of Michigan Herbarium).

[1] Papers from the University of Michigan Herbarium. The field and herbarium studies have been supported by funds from the Horace H. Rackham School of Graduate Studies of the University of Michigan, and by the Carnegie Institution of Washington.

Struthanthus macrostachyus sp. nov.

Frutex epiphyticus omnino glaber. Folia petiolata, coriacea, late elliptica, apice rotundata, apiculata, raro emarginata, basi acuta. Inflorescentiae axillares, solitariae, subspicatae, usque ad 20 cm. longae. Flores sessiles. Petala linearia, fere 5 mm. longa. Stylus fere 4 mm. longus.

A woody epiphytic vine, entirely glabrous. Branchlets subterete, obscurely striate, somewhat compressed at the nodes, the internodes 4 to 10 cm. long. Petioles canaliculate, 1.5 to 2.3 cm. long. Leaf blades coriaceous, broadly elliptic, 7 to 11 cm. long, 4.5 to 7.5 cm. wide, apex rounded or emarginate, sharply apiculate, base rather abruptly acute, decurrent, costa plane above, prominent beneath, primary veins 7 to 10 on each side, very inconspicuous. Inflorescence subspicate, axillary, solitary, up to 20 cm. long; the axis striate; the flower clusters remote, subsessile. Flowers about 6 mm. long, sessile, in clusters of 3. The 3 bractlets subtending flowers persistent, broadly ovate, acute. Calyx shallowly dentate, subtruncate. Petals 6, linear, about 5 mm. long. Stamens in 2 series; filaments free at apex only; anthers of the 3 short stamens obtusely apiculate. Style straight, about 4 mm. long. Immature fruits sessile, ellipsoid.

MEXICO: Chiapas, on tree in savanna at Palenque, July 9–14, 1939, *Eizi Matuda 3731* (type in the University of Michigan Herbarium).

S. macrostachyus has affinity to *S. belizensis* Lundell.

Struthanthus Matudai sp. nov.

Frutex omnino glaber. Folia petiolata, chartacea, lanceolata vel anguste oblongo-elliptica, apice acuta vel acuminata, raro obtusiuscula, basi acuta. Inflorescentiae axillares, solitariae, cymoso-capitatae, 6- vel 9-florae. Flores sessiles. Petala linearia, fere 5 mm. longa. Stylus contortus, 4 mm. longus.

A woody epiphyte, entirely glabrous, the branchlets slender, short, sharply angled and compressed at the nodes, the internodes 1 to 2.5 cm. long. Petioles canaliculate, 2 to 4.5 mm. long. Leaf blades chartaceous, lanceolate or narrowly oblong-elliptic, 2 to 4.3 cm. long, 1 to 1.7 cm. wide, apex acute or acuminate, sometimes obtusish, base acute, decurrent, costa elevated as a narrow ridge on both surfaces, veins faint above, not discernible beneath. Inflorescences up to 2 cm. long, axillary, cymose-capitate, the flower clusters 2 or 3, subsessile. Flowers 6 mm. long, sessile, 3 in each cluster, each flower subtended by a persistent, fleshy, ovate bractlet. Calyx truncate, obscurely denticulate. Petals 6, linear, about 5 mm. long. Stamens in 2 series; anthers of the shorter 3 sessile, those of the longer 3 subsessile. Style contorted, 4 mm. long.

MEXICO: Chiapas, Mt. Ovando, April 12, 1937, *Eizi Matuda 1808* (type in the University of Michigan Herbarium).

S. Matudai is notable for its sharply angled and compressed branchlets

and long pedunculate capitate flower clusters. The species has been confused with *S. alni* Bartlett of Oaxaca which is resembles superficially.

Struthanthus tacanensis sp. nov.

Frutex. Folia petiolata, coriacea, glauca, lanceolata vel ovato-elliptica, apice acuminata, basi acuta. Inflorescentiae fasciculatae, sessiles, subpaniculatae, usque ad 4 cm. longae. Flores sessiles vel subsessiles. Petala linearia, fere 9 mm. longa. Stylus contortus, 7 mm. longus.

Woody, the branchlets nodose, scurfy, with short internodes. Petioles canaliculate, stout, 3 to 8 mm. long. Leaf blades coriaceous, glaucous, lanceolate or ovate-elliptic, 5 to 9 cm. long, 2 to 5 cm. wide, apex acuminate, base acute, decurrent, costa prominent beneath, nearly plane above, primary veins slender, inconspicuous. Inflorescences up to 4 cm. long, paniculate or subracemose, sessile, fasciculate on the elevated nodes; the flower clusters crowded, on short peduncles up to 2 mm. long. Flowers sessile or subsessile, 10 to 11 mm. long, in clusters of 3 to 7; bractlets deciduous. Calyx truncate, obscurely dentate, shallow. Petals 6, linear, about 9 mm. long. Stamens in 2 series; filaments of the 3 long stamens free at apex; anthers of the 3 short stamens sessile, apiculate. Style contorted, 7 mm. long.

MEXICO: Chiapas, Volcán de Tacaná, Chiquihuite, alt. 2800 m., March 27, 1939, *Eizi Matuda 2840* (type in the University of Michigan Herbarium).

S. tacanensis is noteworthy for its acuminate leaves, sessile fasciculate inflorescences, and large flowers.

Acrodiclidium glaberrimum sp. nov.

Arbor parva, glabra. Folia petiolata, coriacea, areolata, elliptica vel obovato-elliptica, apice subabrupte acuminata, basi acuta. Inflorescentiae axillares, paniculatae, 12 cm. longae. Pedicelli usque ad 3 mm. longi. Flores ca. 2.7 mm. longi, 2.5 mm. diam. Androeceum seriebus 2 exterioribus ligulaceo-foliaceis, tertia fertili, quarta abortiva. Ovarium glabrum.

A tree, entirely glabrous. Branchlets stout, obscurely striate, reddish brown. Petioles stout, canaliculate, up to 2 cm. long. Leaf blades coriaceous, areolate beneath, obscurely so above and nearly smooth, elliptic or obovate-elliptic, 12.5 to 25 cm. long, 5 to 9.5 cm. wide, apex rather abruptly acuminate, base acute, decurrent, costa slightly impressed above, nearly plane, broad and prominent beneath, primary veins 8 to 11 on each side. Inflorescence axillary, paniculate, 12 cm. long, entirely glabrous, drying reddish-black; pedicels up to 3 mm. long, stout. Flowers entirely glabrous, about 2.7 mm. long, 2.5 mm. diam. Perianth tube fleshy, infundibuliform; lobes fleshy, broadly depressed-ovate, about 1 mm. long, subequal, the

outer usually minutely and obtusely apiculate. Stamens of series I and II reduced to staminodes slightly shorter than perianth lobes, the outer foliaceous; stamens of series III sparsely subappressed hairy inside at base, the filaments short, thick; glands flat, pressed into sides of the fleshy filaments and equaling them. Anthers 2-celled, cells extrorse-apical, minute. Stamens of series IV abortive. Ovary included, glabrous.

MEXICO: Chiapas, Volcán de Tacaná, on north side, alt. 2100 m., April 2, 1939, *Eizi Matuda 2981* (type in the University of Michigan Herbarium).

Nectandra perdubia sp. nov.

Arbor parva, ramulis brunneo-tomentosis. Folia petiolata, chartacea, novella utrinque sericea, oblonga vel lanceolato-oblonga, apice caudato-acuminata, basi subattenuata, acuta. Inflorescentiae axillares vel pseudo-terminales, tomentosae. Flores breviter tomentosi, 5.5–7.5 mm. diam. Filamenta pilosa. Ovarium glabrum.

A tree, 10 m. high, 25 cm. diam., branchlets brown tomentose. Petioles stout, short tomentose, 7 to 10 mm. long. Leaf blades chartaceous, at first sericeous on both surfaces, with age glabrous and shiny above, persistently sericeous-puberulent beneath, oblong or lanceolate-oblong, attenuate to each end, up to 25 cm. long, 7 cm. wide, apex usually caudate-acuminate, the acumen obtusish, base acute, costa and primary veins impressed above, prominent beneath, primary veins 7 to 9 on each side, laxly reticulate beneath. Inflorescences tomentellous, axillary, the panicles up to 14 cm. long, clustered at the apex of branchlets giving the appearance of large terminal panicles with reduced leafy bracts. Pedicels tomentose, 2 to 3.5 mm. long. Flowers tomentose, 5.5 to 7.5 mm. in diam.; perianth tube very short, scarcely evident, lobes obovate-elliptic or oblong, rounded at apex. Filaments pilose, those of series I slightly shorter than anthers. Staminodia stipitiform, capitellate, the filaments pilose. Ovary glabrous or with few scattered hairs at base; style short, half as long as ovary or shorter.

MEXICO: Tabasco, Boca del Cerro on the Usumacinta River above Tenosique, in second growth, July 1–5, 1939, *Eizi Matuda 3576* (type in the University of Michigan Herbarium). GUATEMALA: Department of Petén, La Libertad, in flatland forest, June 8, 1933, *C. L. Lundell 3716*, a small tree.

On the basis of its sericeous leaves and pilose filaments, the relationship of *N. perdubia* is with *N. nitida* Mez.

Lundell 3716 from Petén is certainly conspecific, but it has larger flowers (up to 7.5 mm. in diam.), sagittate staminodia equaling or larger than anthers, and filaments of series II often bearing reduced glands at the base. On the basis of the staminodia, the collection would be referable to the genus *Phoebe!*

Nectandra tabascensis sp. nov.

Arbor, ramulis novellis sericeo-tomentellis. Folia petiolata, chartacea, parce sericeo-pilosa, anguste oblonga vel lanceolato-oblonga, apice acuta vel obtusa, basi acutiuscula, reticulata. Inflorescentiae axillares, subcorymboso-paniculatae, albido-tomentosae. Flores albido-tomentosi, diam. ca. 6 mm. Filamenta subnulla, pilosa. Ovarium glabrum.

A tree, branchlets slightly angled, short sericeous, drying blackish. Petioles slender, canaliculate, sericeous, 5 to 9 mm. long. Leaf blades chartaceous, sparsely but persistently sericeous-pilose, narrowly oblong or lanceolate-oblong, 8.5 to 16.5 cm. long, 2.8 to 5 cm. wide, apex acute or obtuse, base acutish, finely reticulate-veined on both surfaces, costa prominent beneath, nearly plane above, primary veins 11 to 13 on each side, conspicuous on both surfaces. Inflorescence axillary, subcorymbose-paniculate, white tomentellous, up to 11 cm. long, with long slender peduncle. Pedicels up to 3.2 mm. long. Flowers white tomentellous, about 6 mm. in diam. Perianth tube well developed. Perianth lobes unequal, broadly elliptic or obovate, the larger about 2.5 mm. long. Filaments obscurely short pilose, less than half as long as the anthers; series III with two large glands at base. Anthers wider than long, emarginate. Staminodia conspicuous, stipitiform. Ovary glabrous; style very short.

MEXICO: Tabasco, La Palma on the San Pedro de Martir River near the Petén border, June 1–6, 1939, *Eizi Matuda 3299* (type in the University of Michigan Herbarium).

The species is closely allied to *N. nitida* Mez.

Ocotea subalata sp. nov.

Arbor, ramulis novellis hirsuto-tomentosis, anguste alatis. Folia petiolata, chartacea, oblongo-oblanceolata vel oblonga, apice abrupte acuminata, basi acuta, supra glabra, subtus subadpresse hirsuta. Inflorescentiae corymboso-paniculatae, subadpresse hirsutae. Flores hermaphroditi, subadpresse hirsuti, ca. 2.5 mm. longi. Filamenta antheras breviora. Staminodia stipitiformia, pilosa. Ovarium glabrum. Bacca ellipsoidea, usque ad 2.5 cm. longa, 1.7 cm. diam.

A tree, branchlets angled and shallowly winged, at first brown hirsute-tomentose, usually drying blackish. Petioles deeply canaliculate, 1.3 to 2 cm. long, at first appressed hairy. Leaf blades chartaceous, oblong-oblanceolate or oblong, 8 to 21 cm. long, 4 to 8.3 cm. wide, apex abruptly acuminate, the acumen obtusish, base acute, entirely glabrous above, persistently but rather sparsely pubescent beneath with subappressed brownish hairs, reticulate-veined beneath, at first inconspicuously reticulate above, costa and veins slightly impressed above, prominent beneath, primary veins 6 to 9 on each side. Inflorescence axillary, corymbose-paniculate, long

stalked, subequaling the leaves in flower, greatly accrescent, becoming as much as 40 cm. long in fruit, subappressed hairy, drying black, angled, often slightly winged. Pedicels up to 4 mm. long, greatly accrescent and enlarged in fruit. Flowers perfect, subappressed hairy, about 2.5 mm. long; perianth tube short, lobes ovate, obtuse. Filaments about half as long as the anthers, rather sparsely appressed puberulent; glands at base of series III sessile, conspicuous. Anthers ovate, obtuse. Ovary glabrous, somewhat longer than style, the style sparsely puberulent. Fruits ellipsoid, black, shining, up to 2.5 cm. long, 1.7 cm. diam., the cupule nearly flat, about 4 mm. high, 1.1 cm. diam.

MEXICO: Chiapas, Volcán de Tacaná, on north side, alt. 2100 m., April 2, 1939, *Eizi Matuda 2957* (type in the University of Michigan Herbarium).

O. subalata is a well marked species of doubtful affinities, notable for the narrowly winged branchlets and peduncles, and the large infructescence.

Persea Matudai sp. nov.

Arbor, ramulis et petiolis albido-tomentosis. Folia petiolata, pilosa, membranacea, late obovata vel elliptica, apice rotundata, basi late truncata, rotundata, vel subcordata, nervis albido-tomentosis. Inflorescentiae racemosae, usque ad 20 cm. longae, albido-tomentosae. Flores tomentosi, pedicellis usque ad 1 cm. longis. Filamenta nulla vel subnulla. Staminodia basi glandulosa. Ovarium adpresse pilosum, stylo aequilongo.

Tree, 10 to 12 m. high, 23 cm. diam., branchlets densely white-tomentose, stout. Petioles white-tomentose, 2.5 to 6 cm. long. Leaf blades membranaceous, paler beneath, broadly obovate or elliptic, 15 to 28 cm. long, 10 to 19 cm. wide, apex rounded, base slightly unequal, broadly truncate, rounded or very shallowly subcordate, persistently white tomentose along the costa and veins, rather sparsely pilose beneath, glabrescent above, midvein slightly impressed above, prominent beneath, pinnately veined, primary veins 10 to 12 on each side, conspicuous beneath. Inflorescence racemose, axillary, up to 20 cm. long, white tomentose, with few flowers and long peduncle; pedicels stout, tomentose, up to 1 cm. long, the bractlets deciduous. Flowers tomentose, 8 to 9 mm. long. Perianth tube well developed, lobes subequal, oblong or ovate-oblong, 5 mm. long, apex rounded. Stamens 9, foliaceous; series I sessile, attached dorsally to perianth lobe, 2.5 mm. long; series II sessile, slightly smaller; series III short stipitate, with two large sessile glands at base of each filament. Anthers 4-celled, elliptic or ovate-elliptic. Staminodia large, subsessile, 2-celled, with conspicuous glands at base, these cohering to glands of series III. Receptacle hirsute. Ovary sparsely appressed hairy, equaling the stout short-pilose style; stigma discoid, blackish.

MEXICO: Chiapas, Escuintla, Las Cadenas, January 5, 1938, *Eizi Matuda 1880* (type in the University of Michigan Herbarium).

P. Matudai is an outstanding species probably allied to *P. floccosa* Mez. The racemose inflorescence, white tomentum of all parts, and exceptionally large very thin obovate leaves are its most obvious distinguishing characteristics. The staminodia are subtended by glands, an unusual condition in the genus.

Esenbeckia Yaaxhokob sp. nov.

Arbor, ramulis strigosis, costatis. Folia alterna, 5- raro 3-foliolata, longe petiolata; foliola integra, chartacea, obovata vel oblanceolata, apice rotundata vel obtusa, basi cuneata. Paniculae terminales, usque ad 12 cm. longae, hispidulo-tomentosae. Calyce parce hispidulo, lobis 5, ciliolatis. Petala 5, glabra. Ovarium tuberculatum.

A tree, up to 10 m. high, 20 cm. diam., branchlets white strigose, costate. Leaves alternate, digitately 3- or 5-foliolate, usually 5-foliolate. Petioles up to 9 cm. long, substrigose, the hairs appressed or subappressed; petiolules variable, sometimes up to 1 cm. long on terminal leaflet. Leaflets entire, chartaceous, obovate or oblanceolate, the terminal leaflets usually about 11 cm. long, 5 cm. wide, sometimes up to 14 cm. long, 6.8 cm. wide, the lateral and basal leaflets smaller, the basal often greatly reduced, as small as 2.5 cm. long, apex rounded, obtuse or retuse, base cuneate, glabrous except for a few subappressed hairs along midvein and at base of blade, finely reticulate veined on both surfaces, costa nearly plane above, prominent beneath, primary veins 9 to 13 on each side. Panicles terminal, many-flowered, up to 12 cm. long, hispidulous-tomentose. Pedicels short, up to 2 mm. long, densely hispidulous. Calyx rather sparsely hispidulous; sepals 5, depressed orbicular, scarcely 1 mm. long, ciliolate. Petals 5, entirely glabrous, punctate, elliptic, 3 to 3.5 mm. long. Filaments about 2.5 mm. long, strongly reflexed after anthesis. Disk thick, lobed, 2 to 2.4 mm. diam. Ovary tuberculate, ovules 2 in each cell. Stigma capitate.

MEXICO: Quintana Roo, Cozumel Island, San Miguel, in scrub forest near the coast, *W. C. Steere 2956* (type in the University of Michigan Herbarium). Coba, in advanced forest about 6 miles east of ruins, July 5, 1938, *C. L. Lundell & Amelia A. Lundell 7831*, a tree, 30 ft. high, 3 in. diam.—Yucatan, near Kaua off the Chichen Itza-Kaua road, in advanced deciduous forest, June 13, 1938, *Lundell & Lundell 7532*, a tree, 30 ft. high, 8 in. diam., vernacular name "*yaaxhokob*." Merida-Progreso road, km. 20, in thicket, July 18, 1938, *Lundell & Lundell 7983*, a small tree.

E. Yaaxhokob has been confused with *E. pentaphylla* (Macfad.) Griseb. It is probably nearer *E. Berlandieri* Baill. The glabrous petals, much smaller obovate leaves of different aspect, and hispidulous-tomentose inflorescences distinguish it from *E. pentaphylla*, while the predominantly 5-foliolate leaves likewise of different aspect, as well as the hispidulous-tomentose panicles, obviously separate it from *E. Berlandieri*.

Polygala petenensis sp. nov.

Frutex. Ramuli strigillosi. Folia petiolata, subcoriacea, lanceolato-elliptica, elliptica vel raro oblanceolata, usque ad 5 cm. longa, apice acuta vel subacuminata, basi acuta, parce strigillosa. Pedunculi fere 1.5 mm. longi. Pedicelli fere 2 mm. longi. Sepala ciliolata, ovata, usque ad 1.5 mm. longa. Petala 3–3.5 mm. longa.

A shrub up to 3 m. high, branchlets slender, wiry, minutely strigillose, the hairs subappressed. Petioles terete, strigillose, up to 4. 5 mm. long. Leaf blades subcoriaceous, lanceolate-elliptic, elliptic or sometimes oblanceolate, 2.8 to 5 cm. long, apex acute or subacuminate, base acute, costa and veins slightly impressed above or plane, rather inconspicuous beneath, sparsely strigillose on both surfaces. Peduncles about 1.5 mm. long, strigillose. Axis of the racemes about 2 mm. long. Pedicels strigillose, about 2 mm. long. Sepals strongly unequal, ovate, the larger 1.5 mm. long, ciliolate, sparsely strigillose on outside. Petals 3, the two upper 3 to 3.5 mm. long, basal half appressed puberulent outside, the free part short pilose within except at apex, constricted at middle, acute, keel 3 to 3.5 mm. long, appressed puberulent laterally. Stamens 3 mm. long, basal two-thirds of tube short appressed pilose, filaments free at apex.

GUATEMALA: Department of Petén, bordering Sabana Zis on top of ridge at northwest end of Lake Petén, May 3, 1933, *C. L. Lundell 3187* (type in the University of Michigan Herbarium), vernacular name "*limonaria cimarron*." BRITISH HONDURAS: Toledo District, Camp 36 of the British Honduran-Guatemalan boundary survey, alt. about 800 m., *W. A. Schipp 1254*, a small shrub growing in swampy places in shade, flowers yellow.

The species is closely allied to *P. jamaicensis* Chod., but may be separated most readily by its smaller acute or short acuminate leaves and smaller flowers. Both collections have been reported as *P. jamaicensis* (Lundell, Carnegie Inst. Wash. Publ. **478**: 44, 46, 65, 199. 1937).

Acalypha tabascensis sp. nov.

Frutex. Stipulae setaceae. Folia petiolata, membranacea, crenato-serrulata, lanceolata vel ovato-lanceolata, apice acuminata vel caudato-acuminata, basi rotundata, parce pilosa vel subglabra. Spicae ♂ axillares, usque ad 10.5 cm. longae. Inflorescentiae ♀ axillares, sessiles; bracteae 1, 2- vel 3-florae, ovatae, fere 4 mm. longae. Ovarium tuberculatum, hirsutum.

A shrub, branchlets slender, puberulent and sparsely pilose, pale reddish-brown, striate. Stipules setaceous, up to 4 mm. long. Petioles 0.35 to 3.2 cm. long, puberulent and sparsely pilose. Leaf blades very variable in size, membranaceous, lanceolate or ovate-lanceolate, 5 to 18 cm. long, 1.8 to 8 cm. wide, apex acuminate or caudate-acuminate, base rounded, or obtuse in smaller leaves, margin crenate-serrulate, sparsely pilose beneath, the

hairs densest along midvein, persistently puberulent and short pilose along the midvein on upper surface, pinnately veined with base 3- or 5-veined, costa and veins subimpressed above, prominent beneath, primary veins 6 to 9 on each side. Staminate inflorescences axillary, slender, up to 10.5 cm. long, pilose; the flowers numerous, fascicled, with slender pilose pedicels. Pistillate inflorescences axillary, each consisting of a single sessile bract bearing 2 or 3 sessile or subsessile flowers; bracts ovate, up to 4 mm. long, coarsely crenate-dentate, the teeth few, almost glabrous. Ovary tuberculate and hirsute, the styles with numerous filiform branches.

MEXICO: Tabasco, near Retiro, south of Tenosique, June 19–25, 1939, *Eizi Matuda 3417* (type in the University of Michigan Herbarium).

The sessile axillary 2- or 3-flowered pistillate inflorescence distinguishes the species. It appears to be related to *A. rafaelensis* Standl., and is referable to the subgenus Euacalypha, series Pantogynae-Pleurogynae.

Maytenus blepharodes sp. nov.

Frutex; ramuli hirtelli. Folia petiolata, chartacea, integra, hirtella, elliptica, apice acuta, mucronata, basi acuta. Flores solitarii vel fasciculati. Pedicelli fructiferi usque ad 7 mm. longi. Calyx quinquefidus, lobis late ovatis, laciniatis. Ovarium 3- vel 4-loculare, ovulis in loculis solitariis. Capsula late obovoidea.

A shrub, up to 4 m. high, branchlets slender, short, hirtellous. Petioles of leaves on young shoots about 2.5 mm. long, at length up to 4 mm. long, hirtellous. Leaf blades chartaceous, entire, elliptic, 0.8 to 1.8 cm. long, 0.4 to 0.8 cm. wide on young shoots, with age up to 3.5 cm. long, 2 cm. wide, apex acute, mucronate, base acute, the midvein and margin hirtellous-papillate, otherwise essentially glabrous, venation evident but not conspicuous, obscurely reticulate. Inflorescence axillary, usually reduced to a single flower; bractlets red, fimbriate. Pedicels of fruits up to 7 mm. long, puberulent, jointed and bibracteolate about the middle. Calyx glabrous, 5-lobed, the lobes broadly ovate, short fimbriate. Young capsules broadly obovoid, up to 6 mm. long, glabrous, 3- or 4-celled, with one erect ovule in each cell.

COLOMBIA: Department of Santander, vicinity of Vetas, alt. 3100–3250 m., in thicket, Jan. 16–20, 1927, *E. P. Killip & A. C. Smith 17897* (type in the U. S. National Herbarium, no. 1353411).

M. blepharodes belongs to the small group of species which incluces *M. verticillata* (R. & P.) DC. and *M. Woodsoni* Lundell. The small entire mucronate leaves and the type of pubescence distinguish it.

Matayba retusa sp. nov.

Arbor parva. Folia glabra, petiolata; foliola 5 vel 6, petiolulata, integra, oblanceolato-oblonga vel oblonga, apice retusa, basi acuta. Infructescen-

tiae paniculatae, usque ad 30 cm. longae, adpresse puberulae. Calyx 2.3–3 mm. longus, profunde lobatus, piloso-tomentosus. Capsula glabra, 3-lobata, infra medium in stipitem abrupte contracta.

A small tree, branchlets at tip appressed puberulent, glabrous very early. Leaves alternate; petioles 3.5 to 6 cm. long; rachis up to 13.5 cm. long, substriate, glabrous very early. Leaflets 5 or 6, alternate or subopposite, with petiolules up to 6 mm. long; the blades entirely glabrous, membranaceous or subchartaceous, essentially entire, oblanceolate-oblong or oblong, 6.5 to 18 cm. long, 2.7 to 5.7 cm. wide, apex narrowed and rounded, retuse, base oblique, often unequal, acute, costa and veins prominent, primary veins 8 to 12 on each side, veinlets reticulate on both surfaces. Infructescences in the axils of fallen leaves on older wood, laxly paniculate, up to 30 cm. long, with long peduncles, striate, at first densely subappressed puberulent. Fruits racemose, on stout puberulent pedicels up to 4 mm. long. Calyx persistent, short pilose-tomentose, lobed to the base, the lobes obovate or lanceolate-oblong, 2.3 to 3 mm. long. Disk thick, short pilose. Capsule glabrous or nearly so, 8 to 10 mm. long, up to 2.5 cm. in diam., deeply 3-lobed, abruptly contracted into a stout stipe slightly below middle. Seed, including aril, about 1 cm. long.

MEXICO: Tabasco, in second growth at Tenosique, June 14–16, 1939, *Eizi Matuda 3403* (type in the University of Michigan Herbarium).

M. retusa differs from the other Mexican and Central American species in its retuse leaflets and comparatively large tomentose calyx lobes.

Thouinidium Matudai sp. nov.

Arbor parva, ramulis puberulis. Folia pinnata, petiolata. Foliola 6–12, membranacea, lanceolata, apice acuta vel obtusiuscula, basi acuta vel rotundata, remote serrulata, glabra. Inflorescentiae puberulae, usque ad 17 cm. longae. Pedicelli fructiferi 3 mm. longi. Fructus 3-alatus.

A tree, 7 m. high, 20 cm. diam., branchlets appressed puberulent. Leaves with petiole up to 4 cm. long, and rachis up to 12 cm. long, the petiole and rachis puberulent with incurved hairs. Leaflets 6 to 12, opposite or subopposite, membranaceous, lanceolate, 4.5 to 8.5 cm. long, 1.6 to 2.6 cm. wide, apex acute or obtusish, base oblique or sometimes rounded in basal leaflets, acute, sparsely puberulent along costa, glabrous otherwise, paler beneath, remotely serrulate, costa elevated above as a narrow ridge, prominent beneath, primary veins 11 to 18, nearly horizontal, prominulous on both surfaces; petiolules puberulent, up to 3 mm. long. Inflorescence terminal, paniculate, up to 17 cm. long, appressed puberulent. Fruiting pedicels glabrous, 3 mm. long. Fruits usually 3-winged, one or two cells often abortive, 2.8 cm. long, 3 to 4 cm. wide (approaching maturity), the wings narrowed to a rounded apex, glabrous except for a few apical hairs, divaricate; style persistent.

MEXICO: Tabasco, on limestone at Boca del Cerro on the Usumacinta River above Tenosique, July 1–5, 1939, *Eizi Matuda 3590* (type in the University of Michigan Herbarium).

From *T. riparium* (Brandeg.) Radlk., which it approaches, *T. Matudai* is distinguishable at once by its considerably larger acute or obtuse leaflets. In *T. riparium* the leaflets are sharply acuminate. Both species are known from imperfect material.

The writer is indebted to Dr. H. L. Mason for making available the type of *T. riparium*.

Orthion oblanceolatum sp. nov.

Arbor. Folia petiolata, chartacea, oblanceolata vel oblongo-oblanceolata, apice subabrupte acuminata, basi acuta, remote subadpresse serrulata, reticulata. Inflorescentiae axillares, cymosae, longe pedunculatae, usque ad 13.5 cm. longae. Capsula pedicellata, obtuse trigona, usque ad 1.3 cm. longa.

A riparian tree, glabrous. Branchlets green, terete. Stipules deciduous. Petioles canaliculate, 4 to 9 mm. long. Leaf blades chartaceous, oblanceolate or oblong-oblanceolate, 7.5 to 16 cm. long, 2.6 to 6.6 cm. wide, apex rather abruptly acuminate, base acute, margin remotely subappressed serrulate, both surfaces reticulate-veined, costa prominent beneath, elevated above as a narrow ridge or plane, primary veins 9 to 11 on each side. Inflorescences cymose, axillary, crowded at apex of branchlets, appearing subumbellate, up to 13.5 cm. long, with long peduncles, the peduncles and branches flattened. Fruiting pedicels up to 6 mm. long, jointed below middle. Persistent sepals 5, unequal, broadly ovate or suborbicular, up to 2 mm. long, apiculate, very minutely erose. Petals sessile, flask-shaped or oblong, rounded at apex, up to 2.6 mm. long. Capsule obtusely trigonous, suborbicular, up to 1.3 cm. long, emarginate, 3- to 5-seeded. Seed globose, about 4 mm. in diam.

GUATEMALA: Department of Petén, "montaña San Simon en la margen del Río Cancuen," April 17, 1935, *Mercedes Aguilar H. 497* (type in the University of Michigan Herbarium).

This violaceous tree is the third species in the recently described genus *Orthion* Standl. & Steyerm. (Field Mus. Bot. **22**: 249. 1940). *O. malpighiifolium* (Standl.) Standl. & Steyerm., the closest species, has narrowly lanceolate attenuate leaves compared with oblanceolate abruptly acuminate leaves in *O. oblanceolatum*.

Casearia tacanensis sp. nov.

Arbor parva, ramulis tomentosis. Folia petiolata, chartacea, oblonga, apice attenuata, acuminata, basi acuta, supra subglabra, subtus pilosa, crenulato-serrulata. Flores tomentosi, fasciculati, pedicellis 5.5–8 mm.

longis. Calyx usque ad 8 mm. longus, segmentis anguste lanceolatis. Stamina 10, parce pilosa. Ovarium hirsutum.

A small tree, 6 to 7 m. high, 15 cm. diam., branchlets brownish tomentose. Petioles tomentose, 3 to 6 mm. long. Leaf blades chartaceous, oblong, 8.5 to 18.5 cm. long, 3.1 to 5.3 cm. wide, apex attenuate, acuminate, base acute, glabrous above except for a few hairs along midvein, persistently brown pilose beneath, densely so along the costa and primary veins, margin inconspicuously crenulate-serrulate, costa and primary veins slightly impressed above, prominent beneath, primary veins 7 to 9 on each side. Flowers fasciculate, the clusters large, many-flowered. Pedicels 5.5 to 8 mm. long, jointed near the middle, brown pilose-tomentose. Calyx tomentellous, up to 8 mm. long including tube about 1.5 mm. long; lobes 5, linear-lanceolate, attenuate, acutish. Stamens 10, sparsely pilose; staminodia densely pilose; filaments united at base into a tube. Ovary and basal two-thirds of style hirsute; stigma capitate.

MEXICO: Chiapas, Volcán de Tacaná, alt. 1000–2000 m., Aug. 1938, *Eizi Matuda 2441* (type in the University of Michigan Herbarium).

Ardisia Matudai sp. nov.

Arbor parva. Folia petiolata, glabra, chartacea, integra, oblonga, elliptica vel oblanceolata, apice subacuminata, acuta vel obtusa, basi acutiuscula. Flores racemosi, albi. Pedicelli usque ad 1.3 cm. longi. Sepala glanduloso-ciliolata, ovata, 3 mm. longa. Petala oblongo-elliptica, usque ad 9 mm. longa. Ovarium glabrum.

A small tree, up to 4 m. high; branchlets stout, glabrous. Petioles narrowly winged, canaliculate, 1 to 1.5 cm. long. Leaf blades glabrous, chartaceous, oblong, elliptic or oblanceolate, 11 to 25 cm. long, 5.3 to 8.8 cm. wide, apex subacuminate, acute or bluntly obtuse, base acutish, decurrent, margin densely purple-punctate and entire, finely reticulate veined, costa impressed above, prominent beneath, primary veins up to 20 on each side. Inflorescence glabrous, terminal, broadly paniculate, up to 16 cm. long, the flowers racemose on the branches. Pedicels up to 1.3 cm. long, glabrous, often reflexed. Flower buds about 8.5 mm. long. Sepals ovate, about 3 mm. long, glandular-ciliolate, punctate. Petals short-connate at base, oblong-elliptic, up to 9 mm. long, rounded or bluntly obtuse, glandular-lepidote within at base, glabrous otherwise. Stamens up to 6 mm. long including the thick filaments up to 1.8 mm. long; anthers conglutinate, acuminate, the apex purple punctate, not punctate otherwise. Ovary glabrous.

MEXICO: Tabasco, La Palma on the San Pedro de Martir River near the Petén border, in advanced forest, June 1–6, 1939, *Eizi Matuda 3295* (type in the University of Michigan Herbarium). San Isidro (between La Palma and Tenosique), in advanced forest, June 7–11, 1939, *Matuda 3364*.—

Chiapas, Javalinero on the Chacamax River, in advanced forest, July 6–9, 1939, *Matuda 3648*.

The leaf variation is considerable, but in all other respects the cited specimens closely agree. The collections were originally determined as *A. Lindenii* Mez, but that species has much smaller leaves, and differs in various other minor characteristics. The relationship of *A. Matudai* is clearly with *A. Lindenii*.

Alseis Schippii sp. nov.

Arbor parva, ramulis minute puberulis. Stipulae 1 cm. longae. Folia petiolata, glabra, membranacea, oblanceolata, utrinque acuminata. Infructescentiae spicatae, axillares et terminales, racheae minute puberulae. Capsula adpresse puberula, ca. 1.5 cm. longa.

A tree about 11 m. high, 15 cm. diam., branchlets at first very minutely puberulent. Stipules deciduous early, lanceolate-subulate, widest at base, 1 cm. long, glabrous outside, bearing appressed setae within. Petioles slender, very minutely puberulent, drying black, up to 2 cm. long. Leaf blades membranaceous, drying blackish, oblanceolate, 10 to 22 cm. long, 3.5 to 7.5 cm. wide, apex acuminate, base decurrent, acuminate, minutely puberulent on the costa beneath and bearing a few coarse hairs in the axils of the primary veins, otherwise entirely glabrous, costa plane above, prominent beneath, primary veins 9 to 13 on each side, plane above, elevated beneath. Flowers in axillary and terminal long stalked spikes, the racheae of spikes stout, densely puberulent, striate, up to 30 cm. long. Bracts narrowly lanceolate-subulate, up to 2.8 mm. long, 1-flowered. Flowers not known. Capsules clavate, sessile or essentially so, striate, appressed puberulent, up to 1.5 cm. long, crowned by persistent oblong obtuse calyx lobes up to 2 mm. long.

BRITISH HONDURAS: Toledo District, Machaca, in forest shade, Nov. 4, 1934, *W. A. Schipp 1230* (type in the University of Michigan Herbarium).

Although *A. Schippii* has been confused with *A. yucatanensis* Standl., its relationship is clearly with *A. Blackiana* Hemsl. of Panama. From the latter is may be easily recognized by the sessile capsules and essentially glabrous leaves with approximately half as many primary veins. The plate of *A. Blackiana* (Biol. Centr. Amer. Bot. 5, tab. 37) shows that species as having leaves with 12 to 22 primary veins, and pedicellate flowers.

Circulation in the Shark Embryo

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For the past decade the author has been interested in the development of the teleost heart and the action of certain drugs on the cardiac, smooth and striated muscles in order to determine the time of innervation (Brinley, 1, 2, 3). During these investigations several different species of fish were studied and it was noticed that they varied a great deal in regard to the distribution of the principal blood vessels and the manner in which the blood passes over the yolk on its return to the heart. Brown trout and northern pike embryos were studied in some detail and are used to illustrate the extremes in the manner of distribution of blood over the yolk (Brinley, 4). In the trout, well defined blood (vitelline) vessels pass over the yolk and return the blood to the heart. In the very young embryos, there are two of these veins, one on each side of the yolk, but as the embryos develop, the left one gradually becomes larger and finally this vessel conducts all the blood from the yolk to the heart and the right vitelline vein completely disappears. When the yolk is absorbed and the membranes composing the yolk sac form the lining of the mid-gut and external body wall, the left vitelline becomes the hepatic vein.

In the northern pike there are no well differentiated capillaries or veins over the yolk but the blood flows through a sinus between the membranes (mesoderm and ectoderm) of the yolk sac on its return to the heart. The hepatic vein develops from this sinus, after consumption of the yolk.

While conducting these studies on the teleost embryos it was thought advisable to extend this work to the Elasmobranch fishes. The nurse shark proved especially desirable for this study. These Elasmobranchs are found in tropical or semitropical waters and are taken abundantly off the southern coast of Florida. The individuals from which these studies were made were collected at Dry Tortugas, 70 miles west of Key West, Florida. The adults are large, 9–12 feet long, sluggish and rather uninteresting fish. In late July and August, these fish migrate into shallow sandy coves near Long Key and can be taken with a spear or gill net. The large majority of the individuals are females. Only one male out of a total of 34 was taken during the summers of 1937 and 1938. All the females, except one, contained developing eggs. The eggs develop freely in the uterus and can be removed by opening the abdomen. Twenty-eight to sixty eggs were obtained from each female. The eggs are equally distributed between the two horns of the uterus. The embryos vary in size in each female, the average

* The writer wishes to express his appreciation to the Carnegie Institution of Washington for an opportunity of working at the Tortugas Laboratory.

variation being about 20 mm.; for example, the embryos in one female varied from six to twenty-six millimeters. The younger stages are found in the anterior region of the uterus and older embryos near the external opening. The variation in size indicates that either a single mating takes place with the male and that the sperm remain alive for some time in the reproductive tract of the female or that more than one mating takes place. Owing to the fact that males are seldom found with the females during the summer it appears as if only one mating takes place.

FIG. 1. Photograph of eggs of nurse shark.

The eggs are about 5.5 inches long, 2.5 inches in greatest diameter and 1.8 inches in thickness (Fig. 1). The shell or chorion is about one millimeter thick, tough and membranous, dark brown in color but transparent. The yolk is about two inches in diameter, surrounded by the "white" of nearly the same viscosity as in the hen egg. The viscosity increases toward the membrane where a thick gel forms adjacent to the chorion.

The eggs will develop outside the body of the female if placed in a running water aquarium or in a live box in the sea. It is advantageous to place a single layer of eggs on a series of trays in the aquarium in order to keep the weight of the top eggs from breaking those below. All dead eggs must be removed as the membranes will rupture and the contents will foul the water. The rate of development depends largely on the temperature. When the temperature of the water is higher, as is usually the case, than the body temperature of the mother, the embryos will develop faster outside than within the female.

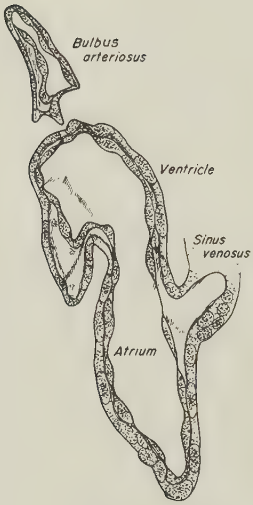
The embryos may be studied in the living condition, for several hours, by cutting away a small portion of the chorion and observing under the lower power binocular, or they may be fixed for sectioning by placing a few cubic centimeters of the fixative directly on the embryo. After two or three minutes the hardened vitelline membrane may be cut around the

embryo, if the embryo is less than 6 mm. long, with fine pointed scissors and by means of a section lifter the embryo can be freed of yolk and placed in a container of the fixative for continued fixation. Older embryos can easily be fixed by cutting the umbilical cord and dropping the detached embryo in the fixative. If it is desired to retain the blood in the embryonic vessels, it is necessary to tie the umbilical cord near the embryo with a fine thread before separating it from the yolk sac. In the studies reported in this paper the embryos were fixed in Bouin's solution and sagittal sections cut 10 and 20μ in thickness, depending upon the size of the embryo, and stained with Delafield's haematoxylin and eosin. A large series of stages were obtained from the neural groove to embryos 6 cm. in length.

The heart when first recognized in a sectioned 2 mm. embryo lies adjacent to the yolk about one-third the length of the embryo from the anterior end. In this stage the heart consists of two tubes, one within the other, each tube composed of a single layer of cells (Fig. 2). The inner tube is destined to become the endothelial lining of the adult structure and from the outer tube develops the myocardium. No blood cells are present and it is not known whether or not the heart is contractile at this stage as it was not observed in the living condition.

In 6 mm. embryos (Fig. 3) the heart has greatly increased in size and has formed an incomplete L shaped tube. The posterior end (atrium) is connected dorsally with the sinus venosus. The anterior end differentiates into the ventricle. The two layers, myocardium and endocardium are still composed of a single layer of cells. The bulbus arteriosus appears as an anterior projection of the ventricle and is composed of the same two layers of cells. No valves or sharp line of demarcation separates the various chambers of the heart. At this stage the different divisions are largely recognized by their position and the relationship to the adult structures. A few erythrocytes are present in the chambers and the heart shows slow peristaltic contractions (in the living embryo). The flow of blood can be observed in the heart but there is no evidence of circulation in the yolk sac. Muscular movement of the embryo is evident by spontaneous twitching of the tail.

In 10 mm. embryos (Fig. 4) the circulatory system has made considerable advancement over the 6 mm. stage. The sinus venosus has increased in size and has shifted dorsally to the atrium. All chambers of the heart are still composed of a single layer of endocardium and myocardium. A slight thickening by multiplication of cells occurs at the atrio-ventricular junction which is the first appearance of the cardiac valves. The heart pulsates at the rate of 60 beats per minute at a temperature of 30° C. The blood vessels in the yolk sac consist of a single artery projecting anteriorly from the embryo; this artery bifurcates a short distance from the head and each branch encircles the yolk laterally and unites with a blood vessel arising from a mass of blood forming tissue lying posterior to



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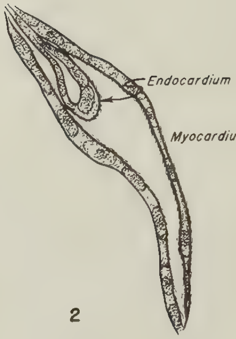

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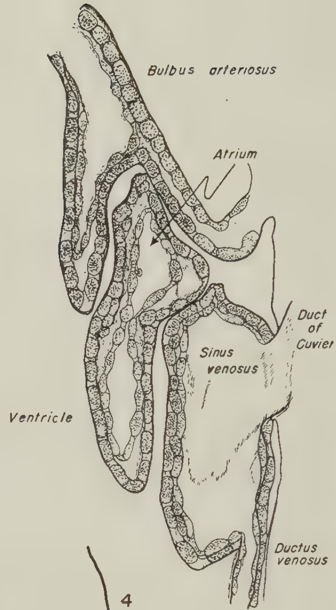

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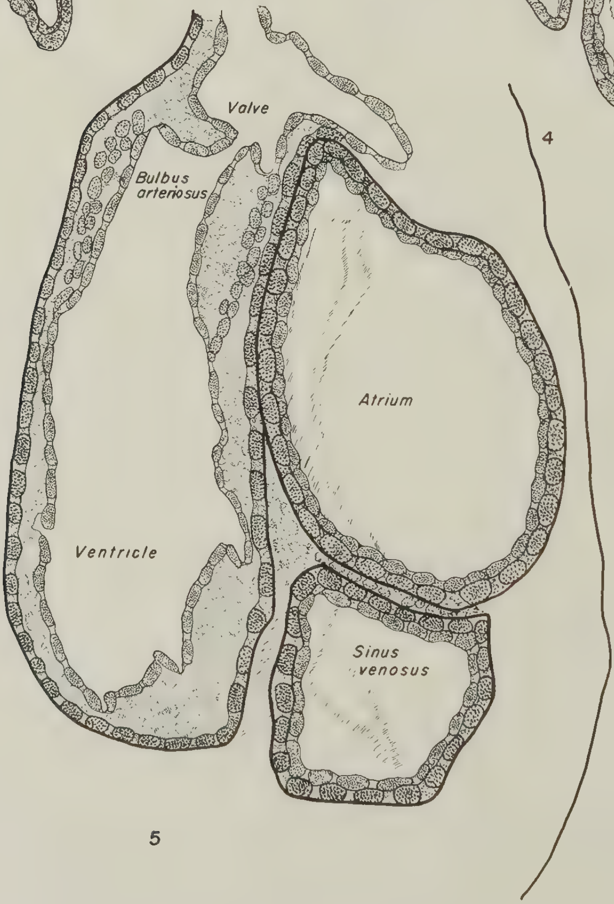

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FIG. 2. Drawing of saggital section, 10μ, of the heart of 2 mm. embryo. FIG. 3. Drawing of heart of 6 mm. embryo. FIG. 4. Drawing of heart of 10 mm. embryo. FIG. 5. Drawing of heart of 48 mm. embryo, 20μ.

the embryo. These three vessels unite into one which returns the blood directly to the sinus venosus. The anterior and posterior cardinal veins have appeared and unite to form the duct of Cuvier before joining the sinus venosus.

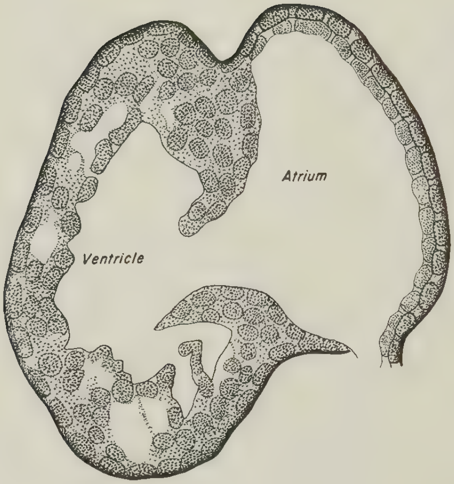
At this stage the embryo is detached from the yolk sac except by a rather long "umbilical cord" which contains a single efferent and afferent blood vessel to the yolk sac. Lateral flexing of the tail occurs at rather definite intervals of every 2 or 3 minutes. The gill arches are plainly visible and the slits connect with the oesophageal cavity which is open anteriorly as the first arch has not yet been modified into jaws.

There appears to be no marked changes in the development of the heart from 10 mm. to 18 mm. In the 18 mm. embryo the thickening at the atrio-ventricular junction becomes the atrio-ventricular valve and the bulbus arteriosus has become somewhat thicker and cone shaped. The sinus venosus and atrium lie dorsally to the ventricle and bulbus arteriosus. The blood vessels completely surround the yolk and many capillaries ramify through the yolk sac. The heart rate has increased to 90 contractions per minute at 30° C. The external gills make their first appearance in the 18 mm. embryo as minute buds on the dorsal surface of the posterior gill arches. The pectoral and dorsal fin buds have appeared. There is active twitching and lateral flexing of the head and tail which seems to originate entirely within the muscle (Brinley, 3).

In the 21 mm. embryo the blood vessel (now called ductus venosus) which returns the blood from the yolk passes through the developing right lobe of the liver and receives blood through the hepatic capillaries from that structure. The ductus venosus also receives blood from the hind gut through the portal vein. The blood from the left lobe of the liver passes directly through a left hepatic vein to the sinus venosus. The artery to the yolk sac arises as a branch from the dorsal aorta, opposite the sixth gill arch and passes between the two lobes of the liver, dorsal to the mid gut where it becomes enclosed in the umbilical cord with the vitelline vein which returns the blood from the yolk. This condition probably originated in the 10 mm. embryo but was difficult to follow in detail in the earlier stage. The walls of the ventricle have increased in thickness to several cells. Gill buds have appeared on each side of the gill arches.

In a later stage, 25 mm., the external gills have increased to about one mm. in length and a single blood capillary extends to the end of each filament and then bends back and enters the dorsal aorta. The gill slits are still open into the oesophageal cavity.

The 33 mm. embryo shows the development of the jaws from the first gill arch and the mouth is formed from the anterior opening of the oesophagus. The spiracle is formed by an incomplete closure of the first gill slit and two or three gill buds project from it at this stage. The gill fila-



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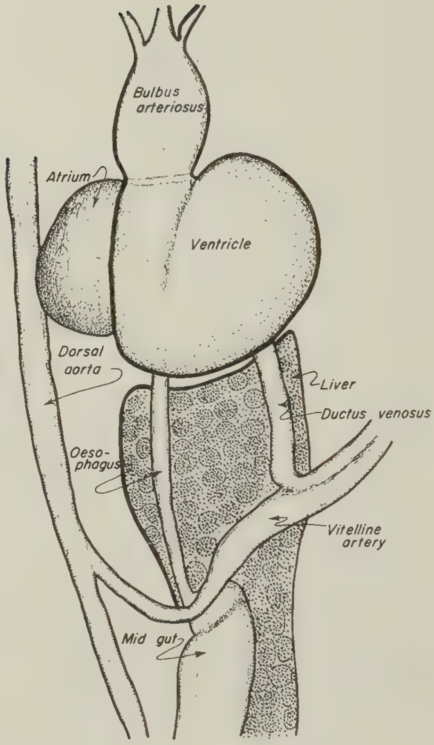

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FIGURES 6–8.

ments from the dorsal wall of the other gill arches have increased to 5 or 6 mm. in length and the gill slits have completely closed.

The heart and main blood vessels have been carefully traced in gross dissected and sectional material in the 48 mm. embryo. The external appearance of the embryo in this stage is quite similar to the 33 mm. stage except for further development of the mouth and eyes. The heart of the 48 mm. embryo shows no new structures nor main blood vessels but there occurs a further development and modification of the structures that have made their appearance in the earlier stages, (21 mm.). The sinus venosus and atrium still consist of a single layer of myocardium and endocardium but the ventricle has developed into a heavy cone shaped structure consisting of a layer of myocardium, 5 or 6 cells in thickness, and a single layer of endocardium (Fig. 5). The myocardium is penetrated with blood sinuses or capillaries (Fig. 6) that connect directly with the lumen of that chamber, so apparently the blood can flow directly from the chamber to the muscular tissue and there appears to be no need for coronary vessels at this stage. The atrio-ventricular valve has developed into a circular flap of membrane without special modification. A single semi-lunar valve has also appeared at the junction of the bulbus arteriosus and ventral aorta. A branch (vitelline artery) from the dorsal aorta, as described in the 21 mm. embryo, carries blood to the yolk sac which is enclosed with the vitelline vein in the umbilical cord. This artery passes between the lobes of the liver (Figs. 7 and 8), dorsally to the mid gut and breaks up into numerous capillaries which completely encircle the yolk. The blood is returned from the yolk to the embryo by the vitelline vein which lies ventrally to the artery in the umbilical cord until it reaches the embryo where it tunnels through the right lobe of the liver (ductus venosus) and receives the hepatic capillaries of that structure and also the blood from the hind gut (spiral valve is quite well developed) by way of the portal vein. The ductus venosus therefore carries blood from the yolk, right lobe of the liver and the gut directly to the sinus venosus. The blood from the left lobe of the liver is carried through a small hepatic vein to the sinus venosus. It appears that when the yolk is completely absorbed, the vitelline vein disappears and the ductus venosus becomes the principal hepatic portal system. Further development of the heart and blood vessels will be continued on older embryos.

FIG. 6. Drawing of atrium and ventricle of 48 mm. embryo, showing blood sinuses in myocardium of ventricle.

FIG. 7. Composite drawing of several sections, sagittal, 20μ, of blood vessels to and from the yolk. Ductus venosus tunnels through the liver and receives blood from hepatic capillaries and portal veins. Vitelline artery originates from dorsal aorta and carries blood to yolk sac.

FIG. 8. Drawing of dissected 48 mm. embryo showing relation of principal blood vessels to the liver. Left lobe of liver dissected away.

SUMMARY

The heart of the nurse shark is first recognized in the sectioned material of the 2 mm. embryo as a double tube, the inner one forms the endocardium and the outer tube the myocardium of the adult structure.

In 6 mm. embryos the heart has formed a ᒐ shaped tube. The posterior end or atrium is connected dorsally with the sinus venosus. The anterior end differentiates into the ventricle. The bulbus arteriosus appears as an anterior projection of the ventricle.

In 10 mm. embryos the sinus venosus has shifted dorsally to the atrium and a thickening by cell multiplication occurs at the atrio-ventricular junction which is the first indication of the cardiac valves. Blood vessels have appeared for the first time in the yolk sac.

In the 18 mm. embryo, the sinus venosus and atrium lie dorsally to the ventricle and bulbus arteriosus.

In the 21 mm. embryo the blood vessel (ductus venosus) which returns the blood from the yolk passes directly through the right lobe of the liver and receives blood from the hepatic capillaries from that lobe. The ductus venosus also receives blood from the hind gut through the portal vein. The blood from the left lobe of the liver passes through a left hepatic vein to the sinus venosus. The artery to the yolk sac arises as a branch from the dorsal aorta.

A careful study of the heart and principal blood vessels was made in dissected and sectioned material of 48 mm. embryos. The sinus venosus and atrium still consist of a single layer of myocardium and endocardium, but the ventricle has developed into a heavy cone shaped structure consisting of a layer of myocardium several cells in thickness. The atrio-ventricular valve is well developed and a semi-lunar valve is present at the junction of the bulbus arteriosus and ventral aorta. The ductus venosus carries blood from the yolk, right lobe of the liver and the hind gut, through the portal vein, directly to the sinus. The blood from the left lobe of the liver is carried to the sinus through a small hepatic vein.

A branch, vitelline artery, from the dorsal aorta carries blood to the yolk sac which is enclosed with the vitelline vein in the umbilical cord. This artery passes between the lobes of the liver, dorsally to the mid gut.

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Certain Genetic Effects of Short-Wave Ultra-Violet Radiation on Drosophila melanogaster

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Although considerable work has been done with the physiological effects of ultra-violet radiation, its genetic effects have not been extensively investigated. A few papers (Guyenot, 1914, Altenburg, 1928-1934, Geigy, 1931, Eloff, 1939) have appeared which deal principally with the mutation-producing effects of unfiltered ultra-violet light; a few others (Muller *et al.*, 1939, Promptov, 1932, Reuss, 1938) deal with mutation-producing effects of definite wave lengths; and a few (Rifenburgh *et al.*, 1939–1940) deal with other effects of unfiltered light. However, no published information seems available regarding the effects, other than mutation-production, of ultra-violet separated from longer waves. Consequently, this study was undertaken to determine, if possible, whether or not monochromatic ultra-violet light has such effects on *Drosophila melanogaster* comparable to those induced by X-rays, radium, or heat.

METHODS

The source of the ultra-violet rays for the following experiments was a Hanovia Luxor Model Alpine Sun Lamp. This lamp uses an air-cooled quartz-mercury-arc burner and consumes approximately 5 amperes at 110 volts. The rays were filtered through a gas-filled quartz chamber. According to calibration by the manufacturer, this filter transmits some 17% of the short ultra-violet rays whose wave lengths range from 2500 to 2900 Ångstrom units, but only traces of the longer rays.

During radiation the flies were at a distance of approximately 23 centimeters from the surface of the burner. A small electric fan was used to cause a current of air to flow across and through the containers holding the flies. This kept the temperature down to within 2° of the general room temperature, which was maintained at 25° C. The lamp was allowed to burn for at least 10 minutes before each radiation was begun in order to insure a uniform ultra-violet output.

It seemed desirable to subject the flies to a radiation dose as strong as they could endure without being sterilized. At the distance of 23 centimeters arbitrarily chosen, the maximum dose for adults and pupae was found to be produced by 25 to 30 minutes of radiation. Therefore 25 minutes was adopted as the standard for pupae and adults. For eggs and young larvae, it was approximately 25 seconds. Several treatments could be given, however, if a few hours elapsed between them. Accordingly, three radiations were given in all but one (Exp. "2SE") of the "eggs and young larvae treated" experiments.

Adults (aged for at least 18 hours after emergence) or pupae were placed in a wire gauze cylinder 1 inch by 1 inch closed at the bottom and open at the top. The cylinder was covered by the filter mentioned above while radiation was in progress. Controls were put in a similar gauze cylinder, covered with a glass plate and placed under the lamp with the experimental flies.

Eggs (and young larvae) to be radiated were allowed to remain on the surface of a mound of medium on a small glass slide where they were deposited by the female. The slide was removed from the mating bottle and placed beneath the filter which was suspended below the lamp at a distance of one inch above the slide. The slide with control eggs was placed under a glass plate also suspended below the lamp at a distance of one inch above the slide.

Eggs were collected by Steen's method (Steen, 1934). About one-half teaspoonful of melted medium (Rifenburgh, 1933) was placed on a narrow glass slide and allowed to cool. A drop of liquid yeast suspension was added and the slide immediately placed in a rather large shell vial with a virgin pair of flies. At the end of the first day the slide bearing eggs which had been deposited on it was removed, discarded, and a new slide with fresh medium substituted for it. At the end of the second day this was discarded and a third slide of medium placed in the vial with the flies. Since it has been shown (Hanson and Ferris, 1929) that the peak of egg production is reached on the third or fourth day, eggs from the third day only were used. The third slide was removed after being exposed to the deposition of eggs for approximately 20 hours. Immediately the eggs on it were radiated for 20 seconds, the parents discarded, a few drops of water placed in the shell vial and the slide replaced therein. In order to retain the water in the vial, it was inclined, but the angle of inclination was kept low (about 15° from the horizontal) to prevent the emerged larvae from falling off the slide.

After a few hours the eggs and newly emerged larvae were radiated again and replaced in the vial. Some hours later they were radiated a third and last time. Instead of being returned to the vial, the slide then was placed in a regular four-ounce mating bottle having a day's growth of yeast on the surface of the medium. The adults that emerged were removed, examined, counted, and recorded at intervals during the emergence period. These adults were then discarded or used for subsequent matings according to the requirements of the several experiments.

The following experiments were performed in which eggs and young larvae were radiated:

Exp. "2SE" radiated once only—30 seconds at 22 hours;
Exp. "3SE" radiated three times for 20 seconds each at 20 hours, 36 hours, and 47 hours;
Exp. "6" radiated three times for 20 seconds each at 25 hours, 42 hours, and 65 hours;

Exp. "6A" radiated three times for 20 seconds each at 23 hours, 31 hours, and 38 hours;
Exp. "8" radiated three times for 20 seconds each at 21 hours, 34 hours, and 48 hours;
Exp. "9" radiated three times for 20 seconds each for 21 hours, $29\frac{1}{2}$ hours, and $42\frac{1}{2}$ hours.

It should be noted in this connection that the number of hours given here indicates the numbers of hours after the slide was first exposed to the deposition of eggs and is therefore the maximum age for any individual in the group. The average age would be approximately 10 hours less in each case.

In some of the experiments it was desired to obtain as many offspring as was conveniently possible from a given female. In such cases, the female (or both parents) was placed in several successive culture bottles, being allowed to deposit eggs for a period of three days in each. In case a large progeny was desired from a single male, he was mated to several successive groups of females, being allowed to remain one day with each group. These groups of females were then transferred to successive bottles as explained above. In this manner, it was possible in several experiments to obtain thousands of offspring from each male.

Individuals for control matings were taken from identical bottles at the same time as those to be radiated. This insured similarity in age, parentage, and physiological condition for both groups. By this procedure, it was assumed that differences between controls and experimentals, not due to treatment, were largely eliminated.

RESULTS AND DISCUSSION OF EXPERIMENTS

Production of Abnormal Abdomens.—In some preliminary experiments with eggs and young larvae, some abnormal abdomens were noticed; therefore a series of experiments was run in which they were carefully recorded. The results are shown in Table 1.

Approximately half of the individuals with abnormal abdomens were mated *inter se* in regular mating bottles. Their offspring were removed at intervals during the emergence period, examined, counted and recorded. Of the 1246 offspring produced, none were abnormal.

The abnormalities consist of irregularities in the arrangement of the segmental pigmented bands on the dorsal side of the abdomen. These abnormal abdomens seem to be identical with the type pictured and described by Morgan (1915) and said to be non-heritable. They occur under various environmental conditions and have been noticed occasionally in other experiments, but never before in any considerable numbers. Non-heritable abnormal abdomens have been reported also by Morgan, Bridges, and Sturtevant (1925), Promptov (1932) and others. Promptov suggests that they may be characteristic of certain strains. In such case, they must depend upon genotype, as well as environment. Therefore, it was considered advisable to report them in a paper concerned with genetic effects.

TABLE 1. *Occurrence of abnormal abdomens in individuals which were radiated in egg and young larval stages.*

Exp. No.	Experimentals							Controls						
	No. of Bottles	Normal			Abnormal			No. of Bottles	Normal			Abnormal		
		♂♂	♀♀	♂♂+♀♀	♂♂	♀♀	♂♂+♀♀		♂♂	♀♀	♂♂+♀♀	♂♂	♀♀	♂♂+♀♀
2SE	5	18	10	28	6	3	9	5	43	38	81	0	0	0
3SE	12	31	32	63	14	15	29	7	70	61	131	3	1	4
8	25	11	9	20	9	6	15	13	83	82	165	2	2	4
9	28	5	3	8	7	2	9	27	183	147	330	10	7	17
Total	70	65	54	119	36	26	62	52	379	328	707	15	10	25
Total % Abnormal	34.25%±2.31%							3.42%±0.45%						

Difference in percentage of abnormals, 30.83%±2.35%. $\frac{\text{D}}{\text{P. E. (diff.)}} = 13.07.$

TABLE 2. *Non-disjunction of X-chromosomes following radiation of females.*

Exp. No.	Stage Treated	Experimentals					Controls				
		Population	Non-disjunction				Population	Non-disjunction			
			♂♂	♀♀	♂♂+♀♀	Rate		♂♂	♀♀	♂♂+♀♀	Rate
N	Adult	11363	1	0	1		34518	4	2	6	
NN	Adult	14539	0	0	0		14218	1	0	1	
N+NN	Total Adults	25902	1	0	1	1:25902	48736	5	2	7	1:6962
S	Pupa	8291	7	0	7	1:1184	15850	13	10	23	1:689
N+NN+S	Pupa and Adult	34193	8	0	8	1:4274	64586	18	12	30	1:2153
Total percentage rate		.0234%±.0056%					.0464%±.0057%				

Difference, .023%±.008%. $\frac{\text{D}}{\text{P. E. (diff.)}} = 2.88.$ Chances of a true difference between groups, 97 in 100.

The radiated individuals had ten times the proportion of abnormals that occurred in the controls, a difference of over thirteen times its probable error. This makes it certain that there is a true difference between the two groups. It is evident that the treatment increased the proportion of abnormal abdomens among flies radiated in the egg and young larval stages. Even the control treatment was partially effective in their production; none appearing, however, among the offspring of abnormal parents when mated in the ordinary manner in regular mating bottles.

Effect on Non-disjunction of X-chromosomes.—In order to determine whether radiation of females had any effect on rate of non-disjunction, virgin females of the genotype $w^e/y\ w\ m$, were radiated and then mated to "wild" males from stock.

Examinations were made several times for each bottle during the period of emergence and records kept. Any eosin female or wild-type male was interpreted as being due to non-disjunction. The results are shown in Table 2.

Although the difference here is small in certain experiments, it is in the same direction for all. A decrease in non-disjunction rate seems to be indicated for treated females as compared to the controls.

Crossing-over in the Male.—Formerly it was supposed that crossing-over never occurred in the male of *Drosophila* (Morgan, 1912, 1914). More recently, however, it has been reported several times, but nearly always after some sort of radiation treatment (Friesen, 1933 and 1937) (Patterson and Suche, 1934) (Moriwaki, 1935) (Whittinghill, 1937). Very recently crossing-over in the male has been observed in this laboratory in connection with low-intensity radiation with unfiltered ultra-violet for a complete generation (Rifenburgh, Walker, and Johnson, 1940).

In one of the "eggs and larvae treated" experiments (Exp. 6) in which males heterzygous for *b vg bw* had been backcrossed to homozygous *b vg bw* females, three crossovers were found. Since crossing-over in the male is rare, other experiments involving larger populations were set up to investigate the effect of radiation on this process. Altogether, 52 radiated males and 48 control males were tested involving a progeny of 27,288 from the experimentals and 30,833 from the controls. Crossing-over occurred in 6 treated males and 1 control male. The results are shown in Tables 3 and 4. Nearly 12% of all the treated males produced crossovers, but only about 2% of the controls. Male 6AX10 is remarkable in showing a crossover rate of 3.83% which is more than $\frac{1}{3}$ of the average rate (10.05%) found in untreated females for the same region of the chromosome (between the black and vestigial loci). The fact that this crossing-over occurred near the attachment of the spindle-fiber, supports the conclusions of others that crossover values are easiest modified in this region (Friesen, 1933) (Muller, 1925) (Schwab, 1935).

TABLE 3. *Crossovers by males producing them.*

Male Number	Experimental or Control	Stage Radiated	b	vg bw	b vg	bw	Total Crossovers	Total Progeny	% C—O
SAC2	C	Pupa			4	1	5	1903	0.26
6X1	Ex	Egg—Larva	1	2			3	3781	0.08
6AX7	Ex	Egg—Larva		2			2	645	0.31
6AX10	Ex	Egg—Larva	10	11			21	548	3.83
6AX12	Ex	Egg—Larva		1			1	607	0.16
6AX23	Ex	Egg—Larva	2				2	464	0.43
6AX28	Ex	Egg—Larva	1				1	545	0.18
Totals			14	16	4	1	35	8493	0.41

TABLE 4. *Recombination (crossover) percentage in the second chromosome of the male.*

Stage Radiated	Exp. No.	Experimentals				Controls				Difference	Diff.
		No. ♂♂ Tested	Population	Recombination %		No. ♂♂ Tested	Population	Recombination %			P. E. (diff.)
				b to vg	vg to bw			b to vg	vg to bw		
Pupae	SA	7	3875	0	0	5	7297	0	.069 ± .021	Decrease .069 ± .021	3.3
Eggs and Young Larvae	6	2	4248	.07 ± .027	0	1	3202	0	0	Increase .070 ± .027	2.6
Eggs and Young Larvae	6A	43	19165	.141 ± .018	0	42	20334	0	0	Increase .141 ± .018	7.7
Eggs and Young Larvae	Total 6+6A	45	23418	.127 ± .016	0	43	23536	0	0	Increase .127 ± .016	7.9
Grand Total		52	27288	.110 ± .014	0	48	30833	0	.016 ± .005	Increase .094 ± .015	6.3

Map Distance (in ♀♀) is 18.5 (Morgan, 1932). These results are statistically significant.

The case of control male SAC2 in which crossing-over occurred in the remote region of the chromosome seems strange; however, in connection with other experiments in this laboratory, crossing-over has been found in this region in both controls and experimentals (Rifenburgh, Walker, and Johnson, 1940).

Crossing-over in the X-chromosome of the Female.—Virgin females of the genotype $w^e/y\ w\ m$, were radiated and mated to "wild" males from stock. Pairs were allowed to remain in mating bottles for three or four days then transferred to fresh bottles, and the process continued until each pair had been in a series of several bottles. Counts and records were made at intervals during the emergence period.

All the females produced in this cross were "wild" except the non-disjunctional individuals. Consequently, crossing-over could be detected in the males only; therefore, in computing cross-over percentages, the number of observed crossovers was multiplied by two. The following formulae were employed.

1. Between yellow and white loci:

2 × (White-Miniatures + Yellow-Eosins + Whites + Yellow-Eosin-Miniatures)

×100, divided by Total Population.

2. Between white and miniature loci:

2 × (Eosin-Miniatures + Yellow-Whites + Whites + Yellow-Eosin-Miniatures)×100 divided by Total Population.

The results of this study (Tables 5 and 6) are easily interpreted. There is no significant effect in the section between the yellow and white loci. In the region nearer the right end of the chromosome, where the spindle-fiber is attached, there is a significant increase in the case of radiated adults. These results are in agreement with those reported by Muller (1925) for X-rays, by Bridges (1915) for age, and Plough (1917) and Schwab (1935) for heat. These investigators found that treatment caused the greatest effect upon crossing-over near the spindle-fiber attachment, this effect diminishing rapidly as distance from this region increased.

In the case of radiated pupae, the effect is found in the same region. Why this effect should be in the opposite direction, however, is not clear. It may be correlated with a different type of cell division occurring in the earlier stage of germ cell development. On the other hand, it may be that the effect is more indirect, due to the additional thickness of chitin in the pupa case, which probably reduces the penetration of the rays.

Crossing-over in the Second Chromosome of the Female.—Virgin females, heterozygous for black, vestigial and brown, of the genotype $+/b\ vg\ bw$, were radiated and back-crossed to $b\ vg\ bw$ males. The pairs were transferred to successive bottles in the same manner as in the study of the X-chromosome.

TABLE 5. *Recombination percentage in the X-chromosomes of females between the yellow and white loci.*

Stage Radiated	Exp. No.	Experimentals			Controls			Difference	D
		No. ♀♀ Tested	Population	Recombination % y to w	No. ♀♀ Tested	Population	Recombination % y to m		P. E. (diff.)
Adults	N	50	11363	1.11±.066	50	34518	1.05±.037	Increase 0.06±.076	0.79
Adults	NN	25	14539	0.91±.053	25	14218	0.84±.052	Increase 0.07±.074	0.94
Total Adults	N+NN	75	25902	1.00±.041	75	48736	0.99±.030	Increase 0.01±.051	0.2
Pupae	S	12	8291	1.21±.081	20	15850	1.22±.059	Decrease 0.01±.1	0.01

Map distance, 1.5 (Morgan, 1932). None of the above differences are significant.

TABLE 6. *Recombination percentage in the X-chromosomes of females between the white and miniature loci.*

Stage Radiated	Exp. No.	Experimentals			Controls			Difference	D
		No. ♀♀ Tested	Population	Recombination % w to m	No. ♀♀ Tested	Population	Recombination % w to m		P. E. (diff.)
Adults	N	50	11363	30.69±.293	50	34518	34.05±.171	Decrease 3.09±.339	9.12
Adults	NN	25	14539	30.44±.257	25	14218	31.17±.262	Decrease 0.73±.367	1.99
Total Adults	N+NN	75	25902	30.67±.193	75	48736	33.21±.144	Decrease 2.54±.231	11.00
Pupae	S	12	8291	37.08±.358	20	15850	34.90±.255	Increase 2.18±.44	4.95

Map distance, 34.6 (Morgan, 1932).
The differences shown here are significant.

The treated adults have less recombination than the controls.
The treated pupae show more recombination than the controls.

The following formulae were used in computing cross-over percentages.

1. Between black and vestigial loci:
   (Blacks + Vestigial-Browns + Black-Browns + Vestigials) × 100, divided by Total Population.
2. Between vestigial and brown loci:
   (Black-Vestigials + Browns + Black-Browns + Vestigials) × 100, divided by Total Population.

Analysis of the results (Tables 7 and 8) for total radiated adults shows greater probabilities of a significant effect in the region of the spindle-fiber attachment than in the more remote region (97 chances in 100 for the former, 95 chances in 100 for the latter—Garrett, 1926). Furthermore, the effect is in the direction opposite to that in the X-chromosome, which is in agreement with the results of Mavor and Svenson (1923) using X-rays.

Effects of radiation in the region more remote from the spindle-fiber attachment are less clearly shown than in the inclusive region. In the "adult radiated" experiments, the only instance of high statistical significance is in Exp. O. The controls in this experiment have a lower value than any other group, which accounts in part, for the high difference. When the experimentals in Exp. O are compared with the total controls, the difference is reduced to 2.99 times its probable error.

Crossover values in Exp. 6, where eggs and larvae were radiated, show an effect in the opposite direction, but here again, the effect is greater in the region including the spindle-fiber attachment. It is not safe, however, to draw conclusions from this experiment due to the small number of females tested, since different females vary considerably in their crossover rates. The same is true for Exp. SA in which pupae were radiated.

SUMMARY

After radiating *Drosophila melanogaster* with short-wave ultra-violet light in amounts close to sterilization doses, the following effects were observed.

1. The proportion of non-heritable abnormal abdomens was increased greatly by radiation during egg and early larval stages.

2. The rate of non-disjunction was lowered in individuals radiated either as pupae or as adults.

3. Increased crossing-over occurred in the male after repeated radiation of the eggs and young larvae. This was in the region of the spindle-fiber attachment in the second chromosome.

4. Crossing-over between the white and miniature loci was decreased in females after radiation in the adult stage. An increase was obtained following radiation of pupae.

5. Crossing-over between the yellow and white loci was not affected significantly by radiation.

TABLE 7. *Recombination percentage in the second chromosomes of females between the black and vestigial loci (region of spindle-fiber attachment).*

Stage Radiated	Exp. No.	Experimentals			Controls			Difference	D
		No. ♀♀ Tested	Population	Recombination % b to vg	No. ♀♀ Tested	Population	Recombination % b to vg		P. E. (diff.)
Adults	O	20	4629	9.22±.287	20	14031	9.45±.167	Decrease .230±.332	0.69
Adults	OO	23	8115	11.53±.239	17	8496	11.03±.229	Increase .50±.331	1.51
Total Adults	Total O+OO	43	12744	10.70±.187	37	22527	10.05±.135	Increase .65±.228	2.85
Eggs and Young Larvae	6	2	1815	13.50±.541	5	3855	18.44±.421	Decrease 4.95±.685	7.23
Pupae	SA	4	1167	11.8 ±.637	4	2596	10.8 ±.405	.232±.755	0.3

Map distance is 18.5 (Morgan, 1932).

TABLE 8. *Recombination percentage in the second chromosomes of females between the vestigial and brown loci (region remote from spindle-fiber attachment).*

Stage Radiated	Exp. No.	Experimentals			Controls			Difference	D
		No. ♀♀ Tested	Population	Recombination % vg to bw	No. ♀♀ Tested	Population	Recombination % vg to bw		P. E. (diff.)
Adults	O	20	4629	27.91±.445	20	14031	25.40±.248	Increase 2.51±.509	4.9
Adults	OO	23	8115	26.01±.328	17	8496	26.75±.327	Decrease 0.74±.463	1.6
Total Adults	Total O+OO	43	12744	26.70±.264	37	22527	25.91±.197	Increase 0.70±.329	2.4
Eggs and Young Larvae	6	2	1815	27.22±.705	5	3855	29.9 ±.497	Decrease 2.69±.863	3.11
Pupae	SA	4	1167	25.50±.861	4	2596	24.4 ±.569	Increase 1.10±1.03	1.07

Map distance, 37.5 (Morgan, 1932). Significance questionable.

6. The data indicate a slight increase in cross-over percentage near the spindle-fiber attachment of the second chromosome in radiated adult females.

7. The effects, though less in degree, are similar in kind to those induced by heat and X-rays.

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